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FIFTH

AGRICULTURAL REPORT

OF

JAMES HIGGINS, A. M., M. D.

STATE CHEMIST,

TO THE

HOUSE OF DELEGATES

OF THE

STATE OF MARYLAND.

Jan. 8th, 1856. By the House of Delegates, read and thirteen thousand copies ordered to be printed.

Jan. 25th, 1856. By the Senate, read and three thousand copies ordered to be printed.

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REPORT.

In the performance of my duty, I submit a report to your honorable body, touching such matters as will most benefit the Agricultural interest. This duty includes not only the analyzation of soils and of manures, but the notice of any thing else whereby this interest may be properly defended and honestly advanced.

Agriculture needs only fair play, and it asks for nothing else. It demands that it may be instructed by science, taught by practice, and the rules which those two united inculcate, and be defended from any and all influences which seek to rob it of the honest results of its labor. The spirit of the law under which I hold my appointment, as well as the practical wants of the community, require the observance of these rules; to the utmost extent of my ability, I have observed, and shall continue to observe them as long as I hold an official relation to the State, though in this observance, and *because* of it, I may be subjected to the abuse of knaves and the apathy of a class who, though honest, nevertheless are subservient to the interests of others in the same degree that they are neglectful of their own.

The wants of the agricultural community are threefold. First, a knowledge of the composition of their soils; secondly, a knowledge of the manures adapted to meet the deficiencies of soils, and this involves the knowledge of the requirements of crops; and thirdly, and by no means the least important, the obtaining of those prices for crops which the natural laws of supply and demand should regulate, irrespective of, and uninfluenced by speculation and false statements as to the quantity of crops, and false statements as to the ability of the country to meet the demands of consumption.

The necessity of a correct knowledge of the composition and physical character of soils, to those who seek to change the one or to improve the other, by culture and manures, is now so generally conceded, and has been so fully set forth in my previous Reports to your honorable body, that I shall not speak of it to much extent here. The ability of the science of chemistry to determine the presence of substances in a soil necessary to crops, and the quantity which these crops require, is also now fully proven. Let it be conceded that lime, magnesia, plaster of Paris, phosphate of lime, common salt, or potash, are necessary for the growth and development of plants,—and this now no well informed man doubts, or if any do question it, they will only have to refer to their own experience in the use of these substances and the common practice of husbandry in every enlightened neighborhood, for all these substances have been used, some of them for many centuries with remunerative effect, (and no chemist, no vegetable physiologist, no scientific man, no practical farmer who knows how to appreciate the logical value of facts, doubts the truth of this doctrine ;)—let this, I say, be conceded, and the only inquiry then of the husbandman, before applying manures, should be, does the field which I intend to improve already contain these substances in sufficient abundance, and is its physical character such as will enable it to obtain from the atmosphere the elements which plants require from *that* source?

All plants are nourished by the elements of the soil and those derived from the atmosphere. Their roots are implanted in the soil, their leaves expand and grow in the air from which are obtained those things which the soil does not afford. If the soil does not contain the proper substances which it is its duty to supply, then they must be supplied by the application of such manures as may contain them. These propositions are self-evident, and in the event of a barren or unproductive soil, these questions as to the cause of this must be asked—does the barrenness arise from such a defect in the physical condition of the soil as will not enable it to obtain the necessary food from the atmosphere? Is it defective in any of the mineral constituents which plants require for their full development? Or is its poverty produced by the joint influence of these two causes?

In other words, is the soil too stiff or too porous? has it enough of bone earth, or of lime, or of magnesia, or plaster of Paris, or of common salt, or of potash, to supply the demands of the crop which is to be planted or sown on it?

The first of these questions can generally be answered by the experience of practical cultivators of the soil. They can, and do judge correctly (from their personal observation and knowledge,) in determining the kind of soil, *as to texture* best adapted to the various crops cultivated in our climate.

They say, "this particular soil is too light for wheat, another is too stiff for corn; this soil is well adapted to the growth of grass, another proper for tobacco;" but they cannot, without previous trial, discover whether the requisite quantity of nourishing substances, such as bone-earth, plaster, salt or potash, is present. Here the man of practice must invoke the aid of science, and of that science which determines the *quantity* and *quality* of the objects subjected to its investigation.

This science he either must apply himself, or have it applied for him by those whose study and pursuit have been such as to make them familiar with its laws and its practical operations. He must either determine the existence of the various substances by long protracted experience on his soil by the effect of manures containing them, (and for this he must trust the interpretations of chemical science,) or at once reach the object of his wishes by the same means—that is, by seeking from the teachings of Chemistry, the existence or non-existence of the *necessary* constituents of the soil.

The comparative advantages of the two systems I have before mentioned, and will not now repeat them.

The application of the principles of science to various industrial pursuits has been practiced, where the advantage derived from it is far less than that which agriculture acknowledges. If then to partial objects this application be beneficial, why not to those which are so general, so widely practiced, and of such vast importance as the cultivation of the soil, the employment of manures, and the application of the labors of millions of our citizens?

In all of our operations of an industrial kind, whether manufacturing or agricultural, we but act on and carry out the laws of nature; we are but the mere workers of its will, the executors of its commands; of ourselves we can do nothing. We may excite emulation, stimulate enterprise, and arouse a spirit of progress—but unless this spirit is directed by proper knowledge, this progress confined in proper channels, and this emulation directed by proper teachings, our enthusiasm will be expended in vain, and our labor end in disappointed hopes and unrealized expectations. Science and practice must regulate each other, practice must teach and confirm science. Science must advise, and by its investigations aid practice. In union there is strength; this is no more true as to our political system, than as to any of the industrial pursuits followed by our citizens.

In our political system, we have heretofore acted in this manner, and the result is, a government stronger than the strongest despotism in the world, milder and more patriarchal than any of which we know, either from tradition or written history.

As cultivators of the soil, we can only apply natural laws, we cannot change them—we can only use the means which Providence (God in the Highest) has given us. How necessary then to understand these laws, and how useful to investigate the nature of the means by which we must operate. Without the knowledge acquired by these investigations applied to agriculture, it will fall behind, in a great degree, all other industrial pursuits. They employ all that true science teaches, experiments prove, or art inculcates; like the bee, they sip honey for their good from every flower. Shall the farmer, looking only to his own isolated experience, seek to improve his art by rejecting every thing that comes not within the sphere of his own immediate knowledge and experience? As well may he try to nourish himself by drawing from his bosom his own blood?

The practice of farming, taught by its own experience, unaided by science, will ever remain stationary, nay, it must recede, as it has done in all of those countries which have rejected it from their ignorance, or not applied it by reason of the curse of their governments. The countries at one time most fertile and productive, which sustained a population to the acre ten times that of our own, are now mere waste and barren deserts; on these countries the same sun shines as formerly, and the same dews are distilled; but practice has refused the teachings of science because ignorant of its benefits, and the State, looking to the interests of the few, careless of the rights of the many, has not unfolded to them its advantages. Such will be our condition (nay, in some places has it not been so already?) unless we, warned by their example, avoid their errors. Without the knowledge derived from scientific investigations, the art of agriculture must recede, or at least remain where it now is.

Either we must follow in the track of those who have gone before us, merely because they made it, and we know no other, or we must follow some authority without a why or wherefore, or we must improve by our unaided knowledge and experience the art which we follow, irrespective of, and uninfluenced by, assistance from any quarter. We must trust to one fact, not to many, and that which does not come under our own experience must be rejected, according to this view of the case. Experience or practice must, according to this doctrine, stand aloof from all assistance, from any thing else. This is just as wise as one who, traveling to a distant city, would travel on foot, because he knew that in this way he could get there, and refuse a rail road conveyance because never having ridden on it before. We must not inclose ourselves in a nutshell, the world is before us for our instruction, and we should learn useful lessons from all that it teaches. The farmer can hope for but little progress if he trusts to his own exclusive experience; he cannot profit but little from the experience of others, unless by knowing the conditions on which their success depended. Let him study as he may or reflect as he can, still he has no materials for a rational system. The success of one particular practical operation in the culture or manuring of a soil may mislead him, nay, will do so, unless used exactly under the same circumstances as to the nutrient composition of the surface soil and sub-soil, and the mechanical or physical texture of the same. Farmers in particular districts of country plow deep, and thereby improve their soil, and increase their crops; with shallow plowing their labor meets with no return, and their capital gives no interest. In other sections, on a different soil, shallow plowing is remunerative, deep plowing destructive, not only to the crop which succeeds it, but for many others for many years.

On the WHITE OAK LANDS of the Eastern Shore, and on those also in Baltimore and in Anne Arundel, Charles and St. Mary's counties, the plowing of the land to the depth of ten inches would, nay, it has prevented a good crop in the first season, and the land thus treated has failed to regain its pristine fertility for many years afterwards. Examples of this I have known, and can give. In the heavy clays of Frederick and Washington counties, and in the granite soils of Harford, Howard and Montgomery counties, this system (deep plowing) is what the nature of the soil requires. In these counties if a farmer should plow only three or four inches deep, his crop would entirely fail. Let the practice of the latter be followed by the former, or vice versa, and what will be the consequence? Disappointment and unrequited labor. Let the farmers know the causes which produce this state of things and they will avoid them. Practice, without science, can only be of a limited, restricted, narrow use. Practice, with science, will extend its benefits as far as the one is known and the other followed. The most insignificant things are the subjects of both art and science. The painter, the sculptor, the architect, the constructor of ships which "go down to the great deep," all follow certain scientific laws, and by these laws they work and do their labor, and just in the same ratio that they practice these laws, they on the one side gratify our pleasurable emotions, or on the other conduce to our material wants and our pecuniary interests. The fine arts, as they are called, do not rest on any arbitrary laws as to the mode of providing pleasurable emotions, but are governed by fixed, determinate rules, more difficult to be understood than those which regulate and govern the material world, because, although belonging to the domain of the ideal and of our *spiritual* being, yet they are still capable of being perfectly taught, and perfectly understood by those who study the works of different ages and different nations.

All human pursuits are vague and unprogressive unless assisted by science. Well known facts may sleep for centuries, until brought to life by the touch of the wand of science. Like the seeds encased with Egyptian mummies, they remain as they are, unchanged, of no use, and of no benefit, but being warmed by the sun, and moistened by the dews, they expand, grow, and fulfil the end for which their Creator designed them. They either become "most beautiful to the sight," and thus gratify our sensations of pleasure, or being nutritious to the body, conduce to our physical wants.

An objection urged against science is, that it changes. This is its highest boast, *it does not stand still, it is progressive*, when in error it acknowledges and improves by it. Modest and unassuming, it is teachable, and asks for teaching; when taught, it receives instruction gratefully, and at once dispenses its benefits to all around. We claim not for it perfection, we only claim that it can aid practice and improve it. Such it has done in every art, such it has done in agriculture, such, if *properly* administered, it will continue to do.

There are no counselors so safe as those who will forsake an error when they know it, none so reliable as those who confess the truth, though it may confound their vanity and be repugnant to their self-esteem. If Agricultural Science has been in error, its errors have ever leaned to virtue's side, and when known have been acknowledged and avoided. If it has ever struck on rocks or quicksands, at once it raised a beacon there to warn others of the danger. Content and proud indeed, if from the ruins of a cherished theory it could raise a structure which could benefit others; regardless of self-esteem, its honor has been that others have prospered by it; it has no false shame at mistakes, because it knows that we are all fallible, but exults in knowing them, because then it has advanced one step nearer to divine perfection. This science then should be taught to our people and imparted to the rising generation.

It has been urged that Agricultural Science is faulty; is not practice very frequently so too? But here let me give warning. Let not this virgin science, pure in her heart, uncontaminated in her person, be blamed for the acts of the meretricious harlot "Humbug," that steals the robe of innocence in order to gratify her unhallowed lusts.

Agricultural science is the embodiment of common sense and common practice, the latter being first corrected in its errors by philosophy and the rules of rational induction. In its determination every fact is thrown before an impartial tribunal and subjected to rigid scrutiny, all that can influence it, is rigidly determined and thoroughly investigated by impartial investigators. Experience gives the evidence, reason sums up the facts, and common sense, the highest order of philosophy, instructs as to the decision, which, being ratified, is thenceforth a truth, and we ascend one step higher on the ladder, whose bottom, though resting on the earth, yet extends towards heaven, the source of all truth. Can, then, science, testified to continually by intelligent and impartial witnesses, be rejected by intelligent and impartial judges? The science of Agriculture and the practice of intelligent farmers cannot be antagonistic, because it is the aggregation of practical results that produces and is the parent of science.

No judgment, however profound, no intellect, however strong, can be certain of arriving at correct conclusions unless they have the material upon which to exercise their functions. The ablest and wisest practical farmer cannot instruct his brethren unless he be thoroughly acquainted with all of the circumstances which influenced his success, he may teach them his mode of cultivation and the *name* of the manures which he uses; but unless he can also tell the *constituents* of his manures and the *substances* in his soil, he can explain only a part of that which conduces to his success. He, with good intentions, may injure instead of benefiting those whom he wishes to instruct.

I call the attention of those who cultivate the soil to the above general truths only for the purpose of applying them to Agriculture. These propositions will not be questioned. How do they apply to Agriculture, and how do they interest your Honorable Body and your constituents?

This involves the utility of the office which I have the honor to hold, and the duty of the State to spread instruction amongst its citizens. In the discussion of this I shall be brief, and only adduce such facts as are known to yourselves. I should be faithless to those for whom I am appointed to labor if I did not set before you some of the results which it has produced, and should be faithless to my own honor if *at this time* I did not give a history of the office and show the reasons why it has not been more beneficial than it has been. In this, though speaking as a *representative* of the Agricultural interest, I claim not exemption from responsibility for any thing which I may say; if I am in error, most happy will I be to correct it; if what I say be true, then those whom the truth may condemn must blame themselves, not me.

In the Dec. Session of the Maryland Legislature of 1847, the law for the creation of the office of State Agricultural Chemist was passed, and in May following the Governor of the State sent to me a commission to discharge its duties. What the expectations were of those who passed that law, is best seen from the report of the chairman of the committee which reported the bill.

They say, "it is not expected that this measure will at once and alone cause to be diffused among the agriculturists of the State, that full and extended knowledge which, it is hoped, will be ultimately imparted. The committee regard it as an initiatory step, by which, from its partial advantages, the farmers throughout the State will be induced to place a proper estimate upon the true merits of a more enlarged system. They hope by its agency to lead those now actively engaged in cultivating the soil, to place within the reach of those who are to succeed them, and for whose interest and happiness they are chiefly stimulated to industry and exertion, the means of tilling it with greater success. It is also believed, that immediate benefits will accrue to themselves, more than sufficient to compensate them and the State, for the trivial expense necessary to be incurred.

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"Place within the reach of the agriculturalists of the State the means of being informed on these subjects, and let them be properly appreciated and used, and the decided conviction of this committee is, that the annual production of the State cannot fail to be largely increased. Let but the vast deposits of mineral, calcareous, and even vegetable materials of improvement be turned to the best advantage, and the true principles of practical agriculture thoroughly understood, and the farming interests of Maryland will be second in point of profit to none other in the Union. The varieties of our soil, our climate, and the facilities of transportation cannot be surpassed, if equaled, by any other State.

"To effect this, time is required, public sentiment must be prepared to appreciate the worth of such a system. And the measure proposed appears to the committee a proper introductory step, which even of itself will be productive of much practical good, and will bring about the first desirable result. When this shall have been effected, true economy will supply the means. Courses of agricultural education will be adopted in the public academies and schools; or schools for that especial purpose will be established. Agriculture will then be placed upon its proper level. It will no longer be regarded as a species of degrading drudgery, requiring neither education nor talent to understand and improve it; but will be inseparably connected with the highest branches of natural science, upon which it is in truth dependent for its ultimate perfection."

Let me here ask any candid man, if all the foregoing expectations have not been more than realized? Are not courses of agricultural education taught in many of our schools, academies and colleges? And is there not a very active effort now on foot to establish an Agricultural College for the special purpose of teaching, eliciting, improving and diffusing the principles of agricultural knowledge? Do not our farmers now cultivate their lands with better success and more profit than heretofore? Are not the productions of the State "largely increased?" Have not our lime-stones and marls ("calcareous deposits") been applied an hundred fold since this office was created, and in consequence of its teachings? Our mineral deposits (coal and iron ore) have been truly described and accurately determined. In the Youghiogheny Valley of Alleghany county alone, the facts elicited and proven by the office, have contributed more to the value of property there than the cost of the whole office to the State. The residents of this section can answer this, and by their answer I will abide. If the direct and "immediate benefits" accruing to the farmers of the State have not been "more than sufficient to compensate them for the trivial expense necessary to be incurred," then hundreds of our fellow-citizens have testified falsely to your Honorable Body, and the reports of the committees on agriculture of the House of Delegates in former sessions are false, and their adoption by the Legislature was *an endorsement of an untruth.*

After discharging the varied duties demanded by the law as far as they could be discharged, I rendered an account of my stewardship to the House of Delegates in the session of 1849 and 1850. In this Report I made the following statement, which you will find on page 77—House Document G:

"The office which the undersigned has the honor to fill being a new one in this State, the bill creating it was, of course, liable to imperfections, which experience only could correct, and I would fail in my duty, were I not to make such recommendations to the Legislature, and people of the State, as would lead to the construction of a law better calculated to carry out their liberal views.

"1st. I shall call your honorable body's attention to the purposes of the present law creating the office of State Agricultural Chemist. 2d. Show in what particulars its errors consist, and recommend such changes as my experience convinces me are necessary. 3d. *Show the utility of the office to the agricultural interest of our State.*

"The intent of the law of 1847, ch. 249, is best shown by its 4th section, which declares:

"'That it shall be the duty of said Agricultural Chemist to analyze specimens of each variety of soil of the county in which he shall be, that may be brought to him, or that he may find to exist, and also to examine and, if necessary, analyze specimens of each kind of marl, or other vegetable or mineral deposit, that may come to his knowledge, in order that his instructions may be of more practical utility.'

"The law in this section was not sufficiently explicit. Its letter could have been carried out, and not one single fact of practical value elicited. The farmer would have been as ignorant of the composition of his soil, of its defects, and of the manure necessary to supply these defects, as if it never had existed. The mere performance of an analysis would have been of no use, unless it could have shown the *quantity*, as well as the mere presence of the several constituents of a soil.

"There is, moreover, this general defect in the law, viz: *that it requires an amount of duty to be performed, in a given time, which no man can perform, as it ought to be done. And no one having any respect for his own reputation, and capable of performing its duties, will ever pretend to do it.*

"Knowing the time to be inadequate to perform all the duties, I devoted myself to that particular class which would confer the greatest benefit to agriculture, viz: the analysis of soils, marls, &c., leaving myself little or no time for the preparation of lectures, though from them one might gain much greater credit in the community, than for any thing else. I have been content to give the result of my investigations in the plainest style, being satisfied that it was better to spend my time in acquiring a large number of facts, otherwise unattainable, than in ornamenting a small number, by studying and writing out lectures. It was better to attend to their substance, than to lose time in improving their form.

"With a law as defective as the one for the creation of the office of State Agricultural Chemist, it is apparent that to carry it out to the letter, would have been to render it null and void, and have subjected myself to the imputation of charlatanry and ignorance.

"I, therefore, in good faith, devoted myself, with all the energy and knowledge which I possessed, to fulfil its spirit, and so to execute it as to meet the wants of those for whom I was appointed to labor.

"All will bear witness that I have diligently discharged its duties, devoting myself *exclusively* to them. I have had no other end in view but that of serving faithfully the agricultural interest, promoting its welfare, and saving it from imposition and loss. The performing of the letter of the law would have taken but little time and trouble; in carrying out its spirit, great labor and incessant application were necessary. It cannot be charged, therefore, that it was from any unworthy motive that I disregarded the letter of the law, since, by so doing, my duties were an hundred fold more arduous, my responsibilities and my labor greatly increased. I preferred to act right, and to perform my duties, so that they might lead to the knowledge of sound principles, and the true philosophy of agriculture. I rely with implicit confidence on the knowledge and good sense of the agricultural community for my justification. I have, at least, the testimony of my own conscience, that I have exerted all my ability to 'act well my part,' a solace greater than all human praise could be, for duties imperfectly performed, even though they should meet with public approval.

"Your honorable body will also recollect that the present law was originally formed for a Principal and Assistant, but that on its final passage the section for the appointment of an assistant was stricken out, while that detailing his duties was retained. There was thus left for me a *double* duty to perform, and, had I taken *double* the time indicated in the law, I still would have been within the time allotted by the original bill."

From this it will be seen that without disguise I properly stated the objects of the law, and candidly my action under it. This Report was made to a body of different political faith from my own, yet they, looking only to the best interests of the State, endorsed my action, said, "Well done, good and faithful servant," and increased my salary to a sum sufficient to meet my expenses. Here at least was an endorsement of the acts by the body whose creature I was, and to whom I had to make my reckoning. I commenced my duties in May, 1848, on the Eastern Shore of

Maryland and ended there the discharge of my duties to it in the winter of 1850. This was a longer time than the law allowed, but as the letter of the law could not be performed, I executed its spirit, and the result is well known. My conduct was fully endorsed.

In the period of time intervening between the publishing of my first and my second Report, the second Gubernatorial District of Maryland had to be examined, but not this alone, I had many duties to perform for other parts of the State. There were queries addressed to me from all parts of it, and substances forwarded for examination sufficient to take up at least one-third of my time. *For some of these examinations I paid out of my own pocket and received no return.* A science new in principles, novel in its application ; a science comparatively but of yesterday, had been ordered by the State to be applied to an Art which was coeval with the oldest recorded history, and I, an humble individual, had been commissioned to make the application. That that which I had been appointed to teach should not fail in my hands, I determined to use every means, expend every thing, save my truth and honor, to have it endorsed by the State and made acceptable to its citizens. This I did, and my witnesses are the representatives of the people of the State at the next session of the Legislature.

I had recommended, in my first report, that a stationary Laboratory and an assistant were necessary to advance the Agricultural interests, and in 1850, I, at *my own expense*, fitted up a Laboratory in the City of Baltimore, and employed, to the utmost extent of my *pecuniary* ability, the services of an Assistant. I found that this was essential to the protection of the interest for which I was appointed to labor; and to protect that interest I acted as I did. The necessity was this. At the time of my first going into office, no manures, save a little marl, or lime or stable manure, badly taken care of, or a few thousand pounds of bone dust, were used in Maryland. The results of my first report showed the utility of these and many other manures when properly applied, how to take care of, and where and how to apply them ; in the interval between my first examinations and my first report, opportunity had been afforded for *practical* tests, and in every instance, as far as I know or have been informed, the practical results were of such a nature as to inspire confidence in the various manures recommended by me.

Manufacturers and commercial men at once set to work to meet the demands created by this new spirit in Agriculture. At once our markets were flooded with artificial manures to meet the practical wants of the agricultural community. There were advertised in the papers Fertilizers for poor, and Renovators of worn-out land, all endorsed by imposing certificates, calculated to mislead the unwary. Very many farmers in the State were deceived at the time by these statements, and to their cost, have also since then been deceived by many others. Men who had a right to information, sought it from me; this I could not give, unless on inspection of the quality of the substance which they sought to know. To carry out then the spirit of the law and protect those from imposition whom it was my duty to serve, I, at *my own expense*, fitted up an office and laboratory in the city of Baltimore, where it was most needed; on the spot where impositions had been and were daily practiced. The Legislature succeeding the first after my appointment, endorsed my acts, made provision for an Assistant and Laboratory, *but at very little more cost to the State than that of the original law.* Private and pecuniary interests, however, were at work in the restriction of the bill for this purpose to two years' duration, and were induced so to act by the causes which I shall here show.

Guano had been introduced into this State, and a law for its inspection passed, in order that the consumer might be protected. This inspection had not been performed—it was and has been only an insurance to the merchant and importer, no protection to the farmer and consumer. This I showed in my first and second Reports; those interested in the matter did not contradict me before a committee of the House of Delegates or before any other tribunal, but took the more successful way of employing interested persons to influence the House of Delegates, which, indirectly under their influence, restricted the law for an Assistant to two years.

The Legislature at this session passed a bill for an Assistant and a Laboratory,—and of the faithful performance of the duties as designed by that law, I shall not speak. Let your honorable body but appoint a committee with power to send for persons and papers, and I will show to you that the farmers and planters of the State derived more benefit from this law by many times over, than ever they paid for either out of their own pockets by direct or indirect taxation. At the last session of your honorable body, a bill was introduced into the Senate and there passed almost unanimously, that the State Chemist should regulate the inspection of Guano. Heretofore there had been no inspection of this article. The importer appointed his own weigher; an appointee of the State Inspector marked the bags which were sent to the importer's agent, and they were filled according to the pleasure of the importer or of his own agents; all that the inspector heretofore did, was to receive a salary, in some years very far above that allowed by the constitution, and give sinecures to his appointees, whose only duty it was to sustain the existing state of things before the Governor and General Assembly. In proof of the above I refer your honorable body to the number of tons of guano annually inspected in the port of Baltimore.

Every dollar of this cost for inspection was taken from the pockets of the consumers, planters and farmers, and this they paid without any return. The inspector did not examine into the article for whose inspection he received and *kept* a salary far above the constitutional limits. Yet sensitive *farmer-loving* gentlemen could talk about expenses and constitutional matters when the State Chemist was concerned, and at no other time. It was all right that the farmers of the State should be taxed many thousand dollars for an inspection which was no inspection; but most atrocious to pay two thousand dollars to another officer who acted well his part, and for whom the farmers of any county were not taxed to the amount of the personal expenses of the State Chemist in that county.

The bill that passed the Senate that the State Chemist should regulate the inspection of guano, was proposed by a whig, referred to a committee, at whose head was the largest farmer in the State, and by his committee reported on favorably and passed by the Senate. It then went to the House, where it was *so amended as to require bond and security for the faithful performance of all his duties, and an inspection (at twenty-five cents per ton in lieu of all other salary,) which should show the exact composition of the article inspected.*

This Senate bill was opposed by the dealers and hucksters in the article, and they at once joined forces with the appointee of the Governor. The democratic members, with three exceptions, voted against this bill, some of them after having voted for its engrossment, and defeated it with the aid of the majority of the Baltimore delegation. The former gave as a reason, that it was taking patronage from a democratic Governor; some of the latter, that a rigid inspection would interfere with the regular course of trade, as if an article which could not bear a rigid inspection, should on that account be sold to our farmers and planters, the loss being that of the latter, all the gain being for the importers and dealers.

This result was brought about by the agency of the outside influence of many politicians in the State, who used either a direct or indirect influence to defeat the Senate bill.

As *politicians*, they told members that its introduction was a blow aimed at the democratic Governor, and some honest democrats believed them; others were induced to vote against this Senate bill because they were told by men who ought to know better, that such a bill was unconstitutional. Others again were appealed to, to defeat the bill on the score of sympathy for the appointee of the Governor, whilst the Comptroller of the Treasury gave it as his "private" opinion, that there was no necessity to provide for an Assistant and Laboratory in any bill, but that the insertion of the amount required for its continuance in the appropriation bill, was all-sufficient. When asked to pay the appropriation for the Assistant, he refused, this opinion being private only, and not binding in the public capacity of the officer who gave it.

There has then for the last two years been no Assistant, and for the last year no provision for a Laboratory. The benefits of the office had been shown to the State; the demands on my services were consequently greatly increased; large and populous agricultural counties had to be examined, and nothing was given to me whereby I might do it.

The same majority that defeated the bill, giving me an Assistant and Laboratory, had voted that twenty-five cents per ton was sufficient for the inspection of guano. When they found that they had a controlling majority, a supplement was made to the existing act and put the inspection at thirty cents; for what reason I cannot attempt to explain. It is true that many who voted for the amended Senate bill, also voted for this; but no choice was left for them; had they failed to do so, the inspection would have remained at forty cents.

These statements the Journal of the last House of Delegates will show, and I am prepared to prove them when called on. The bill from the Senate was defeated by the joint exertions of the most numerous and energetic body of politicians that has in my experience ever sought to influence the action of the House of Delegates, and they were aided by the manure dealers of Baltimore city, and every argument was used by these calculated to incite the prejudice, or bias the judgment of its members. Appeals were made for sympathy for the Governor's appointee; arguments made to show the unconstitutionality of the Senate bill, and members were appealed to, as *party men*, to vote against any bill whereby the patronage of the Governor might be diminished. These united influences, seconded by the *private* opinion of the Comptroller, were successful. But when the question arose as to the other appointees of the Governor, (about forty in number,) though the lobby members who opposed the Senate bill had excited party spirit and procured a party vote against it, none of them exerted themselves in defence of these other nominees, and they were left to their fate. The License bill was passed, and the democratic nominees of a democratic Governor were bereft of their offices in direct consequence of the action of those democratic members of the House, who had been instigated to defeat the Senate bill for a rigid inspection, requiring the inspector to give bond and security for the faithful performance of all his duties.

Under this state of things, with no Assistant, with increased inquiries for information and increased demand for my services, it was impossible that I would meet them all. I, as far as my ability permitted, retained the services of my former Assistant, and in my absence he has done a vast amount of unrequited labor and service to the farmers of the State.

During the past year *the State neither furnished me with Assistant nor Laboratory*—the appropriation for the latter being only *fifty* dollars, and the mere rent alone of the rooms necessary for my investigations in the cheapest building in the city, being *one hundred dollars*. In this state of things I had either to do nothing or advance from my own pocket the sum necessary for the support of the Laboratory. I appealed to his Excellency, the Governor, for some appropriation from the contingent fund to meet the necessary expenses of discharging my duties so far as analyses were concerned, but this could not be done, and I then sought from him instructions as to the mode, in this condition of things, of discharging my duty, and received the following reply:

"In relation to the last clause of your letter, asking information 'as to what course of conduct you shall pursue so as to discharge the duties of your office,' in the event that no provision is made for the Laboratory, I beg leave to say that your own better judgment, experience and knowledge of the resources at your command, will be a safer guide for your official conduct, than any suggestions which I could offer."

I was thus left entirely to my own discretion, and have maintained the Laboratory for the last year out of my private means, small as they are. If then there has been any failure to meet what was expected of me, let the blame rest with those who contrived that I should be left without the means to meet the public expectation. Is it generous, nay, is it fair or just that I or the office should be blamed by the people of the State for not doing that which the State made no provision for my doing, and which left me without the means of performing duties save by expenditures from my own pocket? Yet the farmers of the State have been well served.—There was at my office a most able, industrious and intelligent gentleman, who gave all necessary information gratuitously to farmers who called there.

Examinations and analyses as far as practicable have been made of a large section of the State, and by the success of the recommendations which I have made in these, I am most willing to abide.

From the above it will be seen that this office has not and could not be of any pecuniary profit to me, and that I have used it with no such end in view, therefore can I speak of its utility to all, and of its necessity indeed to a large portion of our fellow-citizens. Let it be judged by its fruits, and even if these have not been abundant, they greatly exceed its cost.

Since the creation of the office, the use of all the *permanent* manures, such as lime, phosphatic guanos and bone-dust, has increased an hundred fold, and in a great degree by reason of, and by the immediate and direct influence of, its teachings. Varieties of lime, such as magnesian limes and gas-house lime, now meet with ready sale, and benefit alike the merchant and the consumer. The increased price of, consequent on the increased demand for refuse packing salt, has given more profit to the commerce of Baltimore than she has ever contributed to the office.—When this office was first instituted it had a slow sale, at about fifteen cents per bushel, now it is engaged for months in advance at twenty-five cents per bushel.

Magnesian lime was shunned as something injurious, now hundreds of thousands of bushels are used every year, and when applied to soils *deficient* in magnesia, with a greater advantage than the pure limes. These soils have been pointed out in every section of the State where I have been, and as far as I know, not a single practical result has contradicted the advice given as to the application of this lime—and moreover no condemnation of the various manures sold at a price far above their value—no information as to guanos sold under the same circumstances—no recommendation as to the proper law for the inspection of this article ever came from any other source than the office of the State Chemist; and the present law on this subject, which allows guano to be marked with the same mark, in the case of the Peruvian guano differing 12 per cent. in its most valuable constituent, and in the case of phosphatic guano 25 per cent., has its preamble copied from my second report, which preamble enunciates a principle which the law does not carry into effect.

But, apart from all of this, the dissemination of practical truths through the community, the activity given to the public mind by its being stimulated to inquiry and research into agricultural science and practice, have caused benefits a thousand times greater than the public have in any wise paid for. This is shown by the notorious fact, that more manures are annually sold in Baltimore than in any other two cities in the Union. In no State has there been an office similar to the one for the benefit of agriculture in Maryland. The mere fact of an officer going through the State and discussing agricultural matters, directing public attention to them, is productive of great good; when to this is added practical recommendations, based upon scientific research, the benefits must be greatly increased.

There is, at present, a pressing necessity for some *disinterested* competent person to protect the honest farmers and planters of the country from imposition. Mineral manures are largely manufactured, and the manufacturers, by paying well, can and do receive recommendations from professed scientific men, very far above their merits.

This interest has its paid and hired advocates to advance it, and the farmer requires a competent, honest counselor to protect him from their impositions. When those articles are properly made, they are valuable, when not, they benefit the manufacturer but are a source of loss to the purchaser. It may be said that the purchaser must look to his own interests, but this he cannot do, and he should be warned against danger when he knows not how to avoid it. There should be some one present in our large commercial city to whom persons should have access for the purpose of obtaining this information, who could and would give it, uninfluenced by "fear, favor or affection."

But not only in the purchase of manures is such an officer necessary, there is another matter equally important, indeed, more so to the farmers—that is, the giving to them of most correct information in relation to the quantity and condition of our great staple crops. This was practically exhibited last summer. Before the wheat harvest was finished, most extravagant statements were published in all of our papers, as to the quantity and quality of its yield. The papers, without scarcely a single exception, from Boston to New Orleans, and from Baltimore to the extreme cities of the West and North, all joined in the statements; and not only were they made in relation to the crops of this country, but also those of France, England and Europe generally. The natural effect of these statements, so universally made, was to bring down the price of breadstuffs. Conceiving it to be a part of my duty to give correct information on this subject, I at once sought extended information from *reliable* sources; the result of this was embodied in the following article published in one of our commercial papers, the Baltimore Patriot:

LABORATORY OF STATE CHEMIST,
No. 29 Exchange Building, Baltimore, August 8, 1855.

GENTLEMEN:—In a communication to your paper some time since, I expressed the opinion, derived from my own personal observation and from a large correspondence, that the wheat crop of the present would not exceed that of the last year. One of the morning papers (the American) doubted the correctness of my opinion and the accuracy of the facts on which it was founded, and appealed to the coming harvest to prove the incorrectness of it.

The harvest is now ended, and we have statements as to its product from all parts of our country. What do these say when collated and compared with each other—that we have an extra crop? by no means; only that we have a full crop of wheat of fine quality, to meet the demand for the next twelve months. In some parts of the country the wheat crop has been inferior in quantity to that of last year; in other parts it has exceeded that quantity, but in many parts where large crops have been made, they have been injured by the heavy and continued rains succeeding the harvest.

Compare then the present quantity of wheat on hand with that at the same time last year.

We have not more of new wheat at this time than we had last year. Then there was a large stock of old wheat on hand; now there is scarcely any. This plainly shows a deficit then as to this year, of the quantity of wheat for consumption. What is the latest news of the wheat crops from England? By the Agricultural Gazette of July 21st, (and here let me say that the reports for this paper are collated from reliable correspondents *in every district* in England,) I have the following: "there can be little doubt, taken as a whole, it (the wheat crop) will prove considerably short of last year." It, at any rate, cannot supply the home demand. There can be no importations from the Baltic, none from the Black Sea. Food must be sent to the armies and navies there—with what loss and waste we all know. One-fourth of the quantity of wheat would feed the same population at home that is now consumed in the Crimea.

From all of these facts, then, there must be a foreign demand for our wheat, and we have a less quantity to meet that demand and our own wants, than we had at this time last year. *In the face of all this prices must be maintained at a high figure.* It may suit the views of speculators and monopolists to cry out now, large crops! abundant crops!! tremendous crops!!! bring down the price of wheat, and when they have purchased, change their tune—sing out, "great scarcity of breadstuffs"—obtain the highest prices and make fortunes on the labor of honest industry. But if the producer will attend to his own interest, he will not be deceived by any artifice of the purchaser to reduce the price of wheat. The corn crop, and indeed all of the crops which depend for their growth on this season, bid fair to be very large, being benefited by the drought of the year, as I explained in the

"Sun," a few weeks since, for this will not materially make up for the deficit in our wheat crops, as corn is mostly converted into pork and beef, or fed to horses, mules, &c., and with a large part of our population it is but very little used as a breadstuff.

I furnish you, Mr. Editor, with the above conclusions, which, after mature deliberation, I have arrived at. When I wrote before, as to the wheat crop, I was threatened by anonymous letters for meddling "in what did not concern me," and likely I shall give offence to some by the above. This, to me, is a matter of the least consequence. The consciousness of an honest discharge of my duty is all the reward that I seek, and as to threats for doing that duty, I hold them in no sort of valuation. There has been, and is now, an associated, persistent effort to lessen the price of wheat, by exaggerated statements as to its quantity, and I feel fully justified in placing what I conceive to be the real facts in relation to it, before the agricultural community. I have carefully sought out all means of reliable information, and the conclusions founded on it are at your disposal.

Very truly, &c., JAMES HIGGINS,
State Agricultural Chemist.

This was at once sneered at, ridiculed and condemned by many of the papers in our own and other cities, as devoid even of possibility. I insisted upon the correctness of my conclusions and showed the reasons. The result has fully proven the correctness of my statements, and the statement as to the crops made at the time that they were made, induced thousands of farmers to hold back their grain and realize thousands of dollars by its increased price. This increased price, otherwise, would have gone from the producers' pockets into those of the speculators.

The purchasing interest is sustained by a united intelligent and sometimes unscrupulous body of advocates, that of the farmers by comparatively none. In this condition of things, it is not difficult to know who will be the sufferer. The producers require some one who has the means of correct information at his command to impart it to them. This I did, and the result is well known. *At the very time that foreign agents were buying up our wheat for exportation to France and England, our papers contained almost daily statements of the great surplus of grain raised there.* I have deemed it but due to myself to make the above statements, only as regards the office which I hold. Propositions have been made for its abolition. Is it sound public policy to condemn a public officer who, regardless of his personal and private interest, has sought only to promote the public interest? Is it a good example for public officers to be thus dealt with? Will they not at once be taught to act so as entirely to promote their own and disregard the public interest, when they see those who so act pocketing thousands and meeting with no condemnation? Let this office be abolished, and from whom can the agricultural public seek information? Either from hucksters and dealers, or their hireling advocates whose direct interest is to deceive it. If the office be abolished, the farming community will find that they are the great losers, and there will be no consolation in the reflection that they themselves were the cause of it.

It was my original intention to make up this report only from the actual details of examinations in the counties which I visited since my last report, but the very large number of copies ordered by your honorable body for general circulation, showed that you required something of general interest, and I therefore, have enlarged its original platform, and submit, in addition to the matter originally proposed, a treatise on manures and the above facts and observations of general interest.

MANURES.

It will be remembered that in writing the Third Report to your honorable body, I endeavored to give a description of the different substances which constitute the soil, most especially in reference to their chemical character, and to which I subjoined an approved explanation of their origin and mode of forming the soil. In my Fourth and last Report, I then spoke of them as matters essential to vegetable life, and, guided by the results of actual experiment only, established the relations which exist between them and plants, particularly those which are cultivated. At present I intend to treat of such substances as may be applied to soils in order to meet certain deficiencies that may either originally occur in soils in consequence of a defective formation, or be produced in them by their continued cultivation. Substances of this class, capable of restoring, in the one or the other way, the lost fertility of a soil, are generally known as Manures or Fertilizers, and have been used from the earliest times, long before science enabled us to account for their beneficial action. It is my object to devote the following pages of this treatise to a description of the various kinds of manures employed, and to found upon the resulting facts a series of conclusions relative to their mode of action, and of recommendations in behalf of the most proper mode of their management, as best accord with both practical experience and the present state of science.

We still remember, from our knowledge of the functions of the soil, that its fertility depends on two factors: mechanical texture and directly nourishing capacity, the product being the crop. This fact stands in close relation to the wants of plants. The various single substances which serve as nutriments to plants, and which we find as constituents of their body, are naturally divided into two classes, viz: such as are capable of assuming the gaseous state and then form a constituent of the atmosphere—water, carbonic acid, and ammonia—and such as, by their involatility, are bound to the soil through which they are diffused in minute particles, and are not liable to loss unless assimilated by the plants and subsequently removed with the crop—I mean the phosphates, sulphates, chlorides and silicates of the alkalies and alkaline earths, or the mineral constituents of plants.

These latter substances, though they form a comparatively small part of the body of the plant, are nevertheless indispensable for the development of vegetable life; and it is the absolute quantity of these matters present which we regard as the totality of the directly nourishing capacity of the soil. The means by which they may be supplied to soils deficient in them are given to us in various forms, as bones, mineral phosphorites, Mexican and Columbian guanos, super-phosphates, ashes, common salt, plaster of Paris, &c.

The former class of substances, on the other hand, furnish the material for the main body of the plant, inasmuch as the whole of its combustible or organic part is formed from the constituents of these nutriments. Their supply depends to a large extent on the mechanical texture of the soil; for it is the particular proportion in which the fundamental constituents of soil (sand, clay, lime and humus) are present which causes a more or less perfect communication of the soil with the atmosphere, which furthermore promotes the formation of these very substances in the body of the soil itself, and which also exercises an attractive power for these nutriments, and retains and reserves them if they have once become appropriated by the soil.

Among them, *water* is the most common and abundant, for the supply of which nature provides in a liberal manner. But in spite of its being met with almost every where in nature, we are well aware of the fact that it is not seldom wanted, and then usually at a time when the plants need it most urgently for their final development. The injurious effect of dry seasons on *present* crops is well known. On the other hand we meet soils entirely destitute of productiveness, and find, upon examination, that their sterility is the consequence of their wet condition, they being saturated with moisture, and even permit the water to rest upon them and to remain there for a considerable length of time. If, by some means, the water is removed from this kind of soils, they are at once rendered fertile and fit to reach the highest state of culture.

This state of things shows clearly that the water, though a nutriment to plants that cannot be dispensed with, is nevertheless, to the highest extent injurious to vegetation, if permitted to accumulate in the soil; and as the condition of the soil, as a body at large, is due to its mechanical texture, or to the proportion in which the fundamental constituents are present in it, it follows that a regular supply of this nutriment, neither more nor less than wanted, can only be secured by a proper mechanical texture of the soil. In this case the soil will, at one time, reserve to the utmost, the needed quantity of water, whilst at another, it will freely dispense with all superabundance.

The quantity of water required by plants during their growth is very considerable. It is the medium by which all other nutriments are conveyed to the plants, and with which they dispense again as soon as this function has been fulfilled. Boussingault states that annually by a good crop from one acre, about six millions pounds of water evaporate from the leaves of the plants that was previously taken up by their roots. Besides, plants contain about 12 per cent. of their weight of water in the dry state, which forms a constituent part of their body.

Carbonic acid, the second of this class of nutriments, is the substance from which plants derive all their carbon, or about 43 per cent. of their whole weight. A regular supply of carbonic acid is likewise dependent on the mechanical texture of the soil; for carbonic acid is the product of the decomposition of humus, a substance which forms a fundamental constituent of soils, without which a proper mechanical texture cannot exist. Where there is no humus in the soil, no proper mechanical texture exists, nor can there be any regular source for the supply of carbonic acid to meet the wants of the growing crop. The supply of carbonic acid is, in truth, not altogether dependent on the condition of the soil itself, as is the case with water, which enters the system of plants exclusively through their roots, and therefore always by the medium of the soil. Independently of this manner of assimilation, carbonic acid is also taken up by the plants, to a large extent, directly from the atmosphere by the medium of their leaves. It has even been proven by experiment that plants can be raised in a soil entirely destitute of humus, in which case they are solely referred to this latter mode of appropriating their carbon. This state of things, however, merely shows to what extent plants can be forced to feed themselves in a partial manner, but in no way prove that under this condition their development is the most prosperous. Experience teaches us on the contrary, that the co-operation of the humus in the soil is indispensable for securing a regular supply of carbonic acid to plants, and their production in the most perfect form. The gas arising from the humus furnishes a constant source of carbonic acid for that portion of the atmosphere which immediately rests upon the soil and surrounds the upper part of the plant. It also thoroughly penetrates the soil itself, in the very body of which it is produced, becomes there dissolved in water, and in this form most fit to enter the rootlets of plants and to provide thus a nutriment which plants, in their first period of life, cannot appropriate to themselves otherwise, being without leaves at that time.

A regular supply of carbonic acid for the whole term of the growth of the plant can therefore be secured only by the co-operation of humus, or what is the same, by a proper mechanical texture of the soil, and experience teaches us, in accordance with this, that the beneficial influence of the humus on the production of crops is so great that two soils of equal capacity will, *mutatis mutandis*, yield average crops in proportion to the quantity of humus they contain.

Ammonia, finally, is the substance from which the plant derives all its nitrogen, or about one per cent. of its whole weight. It is, like carbonic acid, a product of the decomposition of organic matter, and therefore most intimately connected with the occurrence of humus. Far the greatest mass of the organic part of plants consists of carbon and the elements of water, (hydrogen and oxygen,) and becomes converted into humus as soon as the vital powers have ceased to exist in it. But there is a series of other organic compounds present in the plant, which, besides the above named elements, contain nitrogen as a constituent part; and as these compounds form the real nutritious matter of the vegetable food by being converted into blood, and subsequently applied to the production of the organs of the animal, they must necessarily accumulate in the animal body and re-appear in a more concentrated form in the carcass or the excrements of animals than they occurred in the body of the plant where they originated. These compounds, whether still existing in the plant or already transformed into constituents of the animal body, when they undergo a process of decomposition, produce humus and, besides, evolve ammonia in proportion to the quantity of nitrogen they contain. The ammonia becomes partly disengaged and is then diffused in the atmosphere, and is partly retained by, and incorporated with, the humus which is simultaneously formed with it.

The atmosphere which is thus constantly supplied with ammonia from organic bodies wherever existing in a state of decay, contains this substance in a considerable quantity, and, to judge from the result of analytical examinations of the atmosphere, sufficiently even to meet the wants of all the growing crops on earth. Practical experiments have also proven, in accordance with this fact, that plants can be raised and brought to perfect development without the aid of any other source furnishing ammonia but the atmosphere; and if the experience of practical farmers advises us *not* solely to rely upon this source, but to take care, besides, of keeping the soil itself well supplied with it, by means of artificial applications of such manures as are capable of producing it,—it is for reasons which are founded upon the same principles that have been discussed already in their relation to the supply of carbonic acid.

An experiment on the production of plants under given conditions for the solution of certain questions, is altogether different from the practice of producing crops, and the conditions under which it can be most satisfactorily effected. In the one case, we investigate to what extent plants can be forced to live on a partial supply of the necessary elements, and judge from the more or less perfect development of all their parts, whether we have to decide in favor of the one or the other doctrine; in the other case, we are anxious to offer to the plant an abundance of its elements, by opening the most various resources for its supply, and estimate the result, not from the fact that the produced plant shows a root, a chaff, and bears seeds in a normal way, but by the quantity of grain and straw which the acre has actually yielded, and thus reduce it to a mere question of dollars and cents. This difference in object and success of two practical pursuits of similar character, is the more necessary to be observed and fairly to be distinguished as their identification has principally originated the apparent but erronecus contradictions that have been supposed to exist between the results of practical experience and the laws of scientific agriculture. A soil which contains all the requisite nutriments for plants but ammonia, or such matters as are capable of producing ammonia, is, as to its productiveness, equal to a soil which contains all the nutriments without exception, but its mineral constituents in a state of combination which makes them unfit for ready action. Plants growing upon the one are solely referred to the supply of ammonia from the atmosphere, and the progress of their development must therefore be in a strict ratio to the quantity of ammonia thus furnished to them; whilst the growth of the plants upon the other soil, rich in ammoniacal compounds, must necessarily depend on the advancement of the degradation of its mineral constituents, and is consequently in proportion to the quantity of soluble salts, which become liberated by this process. Now, if direct experiments have shown that the plants on both soils will once reach maturity and become normally formed, it certainly proves that there is enough of ammonia in the atmosphere to support vegetable life, and that beyond doubt, the ammonia of the atmosphere takes a specific part in the nutrition of plants generally. But there is, at the same time, no reason to suppose that this result of observation, because true in itself, should dictate the rules for practical operations unless scientific agriculture be contradictory to practical farming. If this result is, in fact, of no applicability in practice, it merely proves that the development of plants should not be made dependent on the supply of the necessary substances, but that, on the contrary, an abundance of the necessary substances should at once be offered to the plants, in order to enable them to regulate themselves their supply, according to their state of development; a conclusion which relates most particularly to the plants we cultivate, inasmuch as they have to reach maturity within a certain period of time, or will fail entirely to do so. The spirit of Liebig's mineral theory, against which this objection has been repeatedly raised, makes in no wise the fertility of a soil dependent on its mineral constituents exclusively, nor does it attribute to them any preponderance over ammonia in regard to their importance as nutriments; it only demands the acknowledgment of their equal significance as matters indispensable to vegetable life; and as the mineral constituents can only be supplied by the soil itself, whilst the sources for ammonia are various; it recommends such a system of manuring as is in best accordance with these facts. If we apply ammonia to the one of the soils above referred to, and soluble mineral salts to the other, we restore an equilibrium of the nourishing substances in both soils, and by so doing render them productive in the very spirit of the mineral theory. But we also know that the same result can be effected by putting both soils in the fallow until the one has appropriated to itself the required quantity of ammonia from the atmosphere, the other that of soluble mineral salts, as produced by the steadily advancing degradation of its mineral constituents. A soil which has become deficient in ammonia may, therefore, once regain its fertility without any artificial application being made to it; as can also a soil which is deficient in soluble mineral salts, but contains such constituents as will produce them by their degradation; whilst a soil which has no mineral constituents whatever, will remain unproductive until it is artificially supplied with them by manure.

In practice, where we cannot wait until the soil has recovered its nourishing ingredients by its own exertions, we have to apply both ammoniacal and mineral manures to restore its fertility; and if we choose to apply only the latter, with the expectation that the ammonia required would be furnished by the atmosphere, we would be acting just in the same way as if we had added ammoniacal salts alone to a soil deficient in soluble mineral salts, with the expectation that they would be furnished in time by the process of degradation. In neither case will our expectations be realized in practice, nor are they in compliance with the spirit of the minera theory.

Lawes' and Gilbert's observations illustrate most remarkably the importance of ammonia as a nutriment for plants. They found that the more of nitrogen we apply to a soil by manure, the less is its quantity in the grains of the wheat crop raised upon it; and as the absolute quantity of nitrogen of the whole crop, in toto, is augmented in proportion to that of the soil, it naturally follows that these extra additions made, increased to such an extent the weight and number of the grains, as to effect even a decrease in their *per centage*, or *relative* quantity of nitrogen. Besides, we know by the statements of these agriculturists, that the market price of wheat depends almost exclusively on the quantity of nitrogen in the grains; those containing relatively the least of it, being at the same time the most perfectly developed; they are the heaviest, largest in size, and produce the finest quality of flour. The application of nitrogen to soils, (in the form of ammonia,) therefore, not alone increases the yield of the crop far above the proportion which we at first should anticipate; but it also improves the quality of the produced grain, and thus secures for it the highest price in market.

It has already been remarked that the quantity of ammonia which a soil contains, or is capable of producing, is generally in proportion to the quantity of humus in it. This latter substance, though free of nitrogen itself, is always accompanied by nitrogenous matters, which, as integrant parts of the plant, necessarily decay with its whole body, and become thus intimately incorporated with the humus produced. The nitrogen amounts to about 1-15 of the quantity of carbon of which the humus is composed.

But there is, independently of the supply of ammonia by humus, another source for the acquisition of this nutriment, which is inherent to the body of the soil at large, and therefore also dependent on the mechanical texture of the soil. It has been proven that all soils have more or less the property of attracting the ammonia contained in the atmosphere, and to retain it in a state of combination, which so tightly locks it up in the body of the soil, that it is impossible to extricate it again with water. Water, even, which has been saturated with ammoniacal salts, if suffered to filter through soil, runs off clear at the expense of the ammonia formerly contained in it; as also an atmosphere charged with gaseous ammonia is deprived of it when brought in contact with soil. In all these cases the ammonia is found to have been appropriated by, and incorporated with the soil. Prof. Way recently discovered by his most tedious labors, that a certain class of artificial double silicates exercise, in this respect, a power similar to that of soils, and, for several reasons, he concluded that it was to the presence of portions of these double silicates that soils owed the power above alluded to. Among them the double silicate of lime and alumina was found to be that to which this absorptive power of soils has chiefly to be attributed; this substance is a constituent part of clay, through the mass of which it is diffused in minute particles, and therefore never absent in soils. But if, in accordance with the above, the power of soils for absorbing ammonia is increased with the quantity of clay in them, it is on the other side necessarily lessened again in proportion to the degree of stiffness they assume, at the expense of their porosity and fitness to communicate freely with the atmosphere, and is, therefore, also dependent on the mechanical texture. Direct experiments have shown that the mechanical texture of loamy soils is the most favorable for the performance of this important function of soils; this class of soils, though containing a considerable quantity of clay, is famous for the porous condition of its body, in consequence of which it will permit a free access of the atmosphere to all its parts.

The means and ways for the improvement of the MECHANICAL TEXTURE of soils are various; it may be effected either by a mechanical treatment of the soil itself, as by loosening, deepening, draining, &c., or by extra additions being made to it from without. Of these two methods of improvement, only the latter is an act of manuring in the strictest sense of the term, and subject to our consideration in this place. The substances applied are such as will meet the deficiencies of the one or the other of the fundamental constituents of soil, and in this way restore a proper proportion of their relative quantities. In accordance with this, they may be divided into four classes of manure, viz: silicious, (supplying sand;) argillaceous, (supplying clay;) calcareous, (supplying lime and magnesia,) and organic matter, (supplying humus.)

After the foregoing remarks I will now treat, in particular, of the various kinds of manure employed, whether designed for the improvement of the mechanical texture or for the purpose of increasing the directly nourishing capacity of soils, and will present them in an order which, if not strictly systematical, will best lead to a full understanding of their character and mode of action.

NITROGENOUS MANURES.

Stable or *barn yard manure* is indisputably the chief manure of all, as it offers to the farmer the most natural and efficient means for restoring fertility to his soil. It is formed of the solid and liquid excrements of animals, together with the litter-straw of wheat or indian corn, and is consequently composed of both classes of fertilizing substances; those which, by their physical properties, improve the mechanical texture of soils, as well as those which, being soluble in water, serve as a direct nutriment to plants.

With regard to the former, stable manure acts principally on account of its humus, the high importance of which as a fundamental constituent of soils, has been repeatedly discussed in this and my former reports. Humus promotes the absorptive power of soils for the gases. It keeps the soil warm and at a constant degree of temperature, and, like clay, aids materially in retaining its moisture. But instead of increasing the stiffness of soils as clay does, it renders them, on the contrary, porous and friable, so that the more a soil contains of humus, the more of clay can it contain without becoming close and difficult to be plowed. Its principal feature, however, is its intimate connection with nitrogenous compounds, the transformation of which into ammoniacal products advances statedly with the decomposition of the humus. In this way, humus furnishes to the plants, besides water and carbonic acid, (the product of its own decay,) a constant and appropriate supply of ammonia to the very last of its existence.

As to the latter, (the directly nourishing substances,) it is evident that stable manure contains all the nutriments that were once extracted from the soil by the plants, and subsequently removed from it with the crop, and that its application to the soil is therefore simply an act of restitution, at least so far as it concerns these particular matters. The experiments made by Boussingault with grown animals, by a forage of not more than necessary for their sustenance, have, in fact, directly proven the identity of the ultimate composition of the food consumed, and of those matters which, in the meantime, were ejected from the animal body, as also their equal absolute quantity, if calculated for a certain period of time, at the beginning and end of which, the weight of the animal remained stationary. The totality, however, of the matters ejected from the animal body is in no way fully represented by the solid and liquid excrements alone ; we know that a considerable part of these matters (amounting to about 2-5 of the whole) are evolved in the form of water, carbonic acid and ammonia, from the lungs and through the skin of the animal, by the processes of breathing and perspiration. These substances being volatile, are diffused in the atmosphere, and consequently waste a large portion of the food, by the transformation of which, under the process of life, they were produced ; and it is only the remaining portion of the food which reappears in the form of solid and liquid excrements, and such other substances as milk, &c., as may be collected by the farmer, and thus be of direct benefit to him.

From these facts, relative to the connection between excrements and food, we may judge, a priori, of the most probable composition of the former. We have seen that carbon, hydrogen, nitrogen and oxygen, the constituents of the organic portion of food, become partly separated from it in the animal body, and are evolved in the form of water, carbonic acid and ammonia. The other portion of the food which furnishes the material for excrements, must, therefore, necessarily contain less of organic matter, and as the whole amount of the inorganic constituents remain undivided with it, relatively more of mineral matter than the original food from which it is derived. An examination into the ultimate composition of both, as found by direct analysis, proves the correctness of this conclusion beyond doubt, and discloses, besides, a fact which at once appears interesting and important in its relation to the efficiency of stable manure as a fertilizer. It is the fact, that the excrements of animals contain relatively more of nitrogen than the food from which they are derived, or, in other words, the processes of life transform the food when passing through the animal body into a series of compounds which contain the nitrogen in a form the more concentrated, the more they approach their ultimate destination and final composition. We have seen before, that a portion of the organic part of the food which evolves in the form of water, carbonic acid and ammonia, is all that is subtracted from it whilst under the influence of the vital powers; here we find that, in consequence of this very process, the remaining part, that which furnishes the material for excrements, has increased its quantity of nitrogen far above the proportion in which it originally constituted the food. What is the cause we ask, of so close a connection of two facts, apparently contradicting each other? It admits of but one explanation, as it indisputably proves that the relative quantities of water, carbonic acid and ammonia, as they are evolved from the lungs and through the skin of the animal, do in no way correspond with the proportion in which their ultimate constituents, carbon, hydrogen, oxygen and nitrogen, have originally formed the component parts of the food; there is, in the form of carbonic acid and water, more carbon, hydrogen and oxygen evolved, and consequently, in the form of ammonia, less of nitrogen than it would be the case if the different constituents of food had equally participated in the production of these substances.

In recapitulation of the different processes above alluded to, to which the animal food is subjected whilst under the influence of the vital powers, we may accordingly collect the following conclusions relative to the composition of the excrements if compared with the composition of the food from which they were derived:

1. The absolute quantity of the excrements derived from a certain quantity of food, amounts to not more than about three-fifths by weight of the latter.

2. The absolute quantity of carbon, hydrogen, oxygen and nitrogen in the excrements, is less than their absolute quantity in the food.

3. The absolute quantity of mineral matters is equal to that contained in the food.

4. The per centage (or relative quantity) of mineral matters in the excrements is higher than in the food; and finally,

5. The per centage of nitrogen (that substance which is capable of producing ammonia) is also higher (about double) in the excrements than in the food.

This much as to the relations between food and excrements, so far as they are founded on the ultimate composition of both, as well as on the peculiar changes to which the food is subjected in the animal body. With it we now leave the matters as they occur in the living animal, under the influence of the vital powers, to themselves, and turn next our attention to the changes which occur in the excrements when without the animal body and exposed to the influence of atmospheric air; I mean to say, to the changes they undergo by the process of putrefaction.

The excrements, when no longer in connection with the animal body, soon become intimately mixed with the litter straw of the stables, and remain in this state, at the barn-yard, sometimes for months, before being applied to the soil as manure. The reasons for such a delay in the application are, in no wise, to be attributed to a negligence on the part of the farmer, nor are they altogether conditioned by the necessity to await the proper season for manuring. A *rational* husbandman, one who works understandingly, is besides well aware of the fact that barn-yard manure, in its different phases of putrefaction, will exercise very different effects on a particular kind of soil, and knows, by experience, how far its decomposition has to advance to suit best the soil to which he intends applying it.

It is a well known fact that organic bodies, over which the vital powers have ceased to exercise a control, becoming exposed to the simultaneous influence of air, moisture and heat, will decompose and consequently decay. We say they are "rotting," if no stinking effluvia be evolved from them; and this is the case with all those which are composed of no other elements but carbon, hydrogen and oxygen. Wood-fibre, of which the principal mass of plants is made up, is a representative of this class of organic matters, and its decay consists simply in a slow combustion, produced by its uniting with atmospheric oxygen. Under these circumstances, carbon and hydrogen, the constituents of the fibre, become gradually transformed into gaseous carbonic acid and water, whilst that part of the fibre which remai the
course between the first start of decay and final destru
through many phases of decomposition, and repres
form that which we call humus.

The term "putrefying," on the other hand, is
decay of such organic compounds as are famous
greeable and penetrating smell they evolve, and

with all those which contain, besides the above named elements, nitrogen as a constituent part. Small quantities of sulphur and phosphorus also generally accompany them. Urea, the chief constituent of urine, may be regared as a representative of this class of organic matters, and we may find at once, that its decay or putrefaction differs somewhat from the process mentioned before, as it does not altogether consist in an oxydation of its carbon, hydrogen and nitrogen, at the expense of the atmospheric oxygen. Urea becomes gradually transformed into gaseous carbonic acid and ammonia, of which the former carries away all the original carbon, whilst the latter embraces the whole of its nitrogen and hydrogen. But there is originally not enough of hydrogen in urea so as to combine with the whole of its nitrogen to form ammonia, and the balance must therefore necessarily be furnished by some source from without. In accordance with this, practical observations have shown that it is water to which this important function has to be attributed; the presence of moisture being, as we know, one of the conditions for putrefaction. The water, most remarkably, suffers a gradual decomposition itself, when in contact with the putrefying substance, and becomes thus divided into its elementary constituents, hydrogen and oxygen, of which the former, at the moment of its being liberated, unites with any excess of nitrogen to form ammonia, whilst the latter, in common with the oxygen of the atmospheric air, transforms the whole of the carbon into carbonic acid.

Returning to barn-yard manure, it is evident that we have both classes of organic matters, the rotting and putrefying principles, fairly represented in its composition. There is the litter-straw of wheat or Indian corn, nearly identical with wood-fibre; and on the other side, intimately mixed with the former, the various nitrogenous compounds, including urea, as they occur in the solid and liquid excrements of animals. Left to itself for a sufficiently long time of exposure, barn-yard manure may, therefore, once become wholly converted into water, carbonic acid and ammonia, and will then, with the exception of its mineral constituents, entirely disappear from the ground. This effect is, as we know, actually produced in the body of the soil to which stable manure is applied; our experience teaching us that, in the course of time, no trace of it is left with the soil; but as this final term of existence is, in no wise, intended to be reached at the barn-yard, we may here freely dispense with its consequences as no subject for discussion in this place. All that we desire, for the present, to arrive at, is a knowledge of the changes which stable manure undergoes by putrefaction at the barn yard, or within a certain period of time previous to its being applied to the soil. The peculiarties of these changes will best become apparent by a simple comparison of the composition of stable manure, when in its fresh state, and after having putrefied under necessary precautions. From the result of direct analyses, the following conclusions may at once be drawn:

1. Water, carbonic acid and ammonia, being evolved in the course of putrefaction, reduce the absolute weight of the manure, and thus increase, relatively, the quantity of the involatile portion, or its mineral constituents.

2. There is relatively more of carbonic acid and water evolved and less of ammonia, than is in proportion to the quantities of carbon, hydrogen, oxygen and nitrogen which constitute the manure. The quantity of nitrogen is, therefore, relatively increased in the putrefied manure. And finally:

3. Inasmuch as a part of the oxygen has directly combined with hydrogen and departed in the form of water, the quantity of carbon became also relatively increased, and thus effected a partial change of the original light color of fresh stable manure into the brown, or even black color of that which is putrefied.

These conclusions are very similar to those which we have formerly expressed in relation to the composition of food and excrements; the final products of both processes, of digestion and putrefaction, being richer in nitrogen and mineral matters than the original substances from which they were derived,—the one process is *quasi* a continuation of the other, both producing identical changes. Indeed, the ultimate compositions of food and excrements, fresh stable manure and putrefied barn-yard manure, bear exactly the same relation to each other, and prove, besides, that in each case an entirely new article is produced, provided with specific virtues of its own. Thus barn-yard manure, when putrefied, differs materially from fresh stable manure in composition, character and mode of action; and it is but owing to our present knowledge of these relations that we may henceforth rationally decide whether the one or the other kind should be used for the improvement of particular soils.

It is apparent that soils of a proper mechanical texture, such as are, to an equal extent, both binding and porous, which furthermore possess the required power for retaining moisture without permitting, however, an injurious accumulation of water in their body; which also have the capacity of absorbing and retaining gases, or show, in general, such qualifications as are marks of a high state of culture, and more or less characterized by the presence of a proper quantity of humus in them; it is apparent, I say, that soils of this description will be more benefited by the application of the putrefied than fresh variety of stable manure. The latter may even act injuriously on the condition of these soils, by increasing the quantity of humus already contained in them, far above the proportion which is considered to be proper and most fit for prospering vegetation; whilst the putrefied stable manure, which in the course of putrefaction has lost most of its humus, will supply nothing but the deficiencies of ammoniacal and mineral matters that may occur in these soils, and with them, all that these soils want for being restored to fertility.

All classes of soil, with the exclusion of their extreme members, stiff clays and light sands, possess more or less the properties above alluded to, or may easily obtain them by their own exertions, in a regular course of cultivation. For all these the application of putrefied barn-yard manure is the most advisable and rational. This is not less the case with regard to the improvement of meadow land. Here is no loosening, nor any other mechanical effect intended to be produced for the purpose of improving the texture of the soil, and the application of humus, therefore, of no use whatever. A manure for meadow land is rather expected to contain a maximum of directly nourishing substances in a form ready for assimilation, and as it can only be applied as a top dressing, to possess such physical properties as will most facilitate its uniform distribution over the ground. In both respects, the putrefied manure deserves the preference. It contains, as we know, its fertilizing principles in the most concentrated form, and being, besides, reduced to a state of great fineness and subdivision, offers advantages, as to its management, which fresh stable manure, on account of its coarseness, cannot equally present.

Stiff clay soils and light sandy soils, on the contrary, require, first of all, a change in their mechanical texture; and here fresh stable manure affords the best means on hand to meet the deficiencies in this respect. The humus which it contains in considerable quantity, will render the clay soil more voluminous, loose and porous, and thereby fit to communicate freely with the atmosphere; also, by generating a slow and regular evolution of carbonic acid in the very body of the soil itself, it will, to some extent, compensate the inability of these soils of appropriating carbonic acid from without. Light sandy soils, on the other side, which suffer mostly by an excess of dryness and heat, the necessary consequence of the predominance of quartz-sand in their body, obtain, likewise, in humus a most valuable fundamental constituent which will impart to them the power of retaining moisture and soluble nutriments; and as it envelops and joins the quartz-sand particles, materially aid in tempering their excessive power of absorbing heat. The immense benefit which is derived from the practice of manuring with green crops, is most apparent on these latter kinds of soils; they, very properly, are usually turned in with the stiff clay soils, whilst their application in the form of a top dressing is generally adopted for the improvement of the light sandy varieties.

This is an indirect proof for the correctness of the views, as laid down in the foregoing; the application of a green clover ley being, indeed, in every respect, a substitute for a dressing with fresh stable manure.

The last, and in a practical point of view, the most important matter to be discussed, is the manner in which stable manure should be preserved so as to secure the most beneficial results from its use. The conclusions which we have drawn above, in relation to the composition of both putrefied and fresh stable manure, are only correct when the proper precautions have been taken to preserve it and to regulate the process of its putrefaction. When this is attended to, practice and scientific investigation have shown that there occurs little or no loss in its valuable fertilizing constituents. Every man of common sense must admit that the rules to be adopted for a rational system of saving manure, must be based on the knowledge of changes that occur in the course of its putrefaction, and it is in accordance with our present knowledge of this process that we may lay down the following rules in relation to it:

1st. The ground selected for the deposition of stable manure should be even, in order to permit the equal distribution of the manure on it, and thus secure to the heap uniformity in thickness. Only in this case the process of putrefaction will proceed regularly in every part of the heap, and its body will prove to be of a homogeneous character.

2d. The manure should be protected against the direct rays of the sun, in order to prevent the too rapid advance of the putrefactive process, and a consequent generation of heat which will incur a considerable loss of ammonia. Practical experiments made with equal weights of stable manure exposed to the sun, and with that under cover, show the effect of the latter to be, within a certain time, about 25 per cent. greater than the former.

3d. The manure heap should be kept moderately moist; if it be too dry, the degree of heat then produced will volatilize ammonia; if too wet, an acid humus will be formed which, being soluble, in water, acts very injuriously on vegetation. In order best to attain this end the ground should be slightly inclined, and all the fluid that runs from the heap be collected in a pit, from which it may from time to time be scattered over the heap.

If the above rules are strictly observed, and the necessary arrangements which they require to be made, fairly provided for, no other precautions need to be taken for securing the highest possible effect of this manure. The practice of applying plaster of Paris, copperas, or sulphuric acid, for the purpose of fixing the volatile ammonia, is then unnecessary and may best be entirely dispensed with. Indeed, the sulphate of lime, whether directly added in the form of plaster of Paris, or subsequently produced in it by the application of the other two substances, will be of good service only in the case that enough of water is present to favor the formation of sulphate of ammonia (a fixed ammoniacal salt) on one side, and of carbonate of lime on the other. If, on the contrary, the heap should happen to remain dry for some time, the effect produced by such applications will be quite the reverse. Carbonate of ammonia is then evolved and sulphate of lime regenerated ; and a neglect of attendance to this condition, therefore, much harder felt than when no applications of this sort have been made to the heap at all

We have thus far, exclusively treated of the organic part of stable manure, particularly of its composition and the changes to which it is subject by the process of putrefaction. With regard to the inorganic part, or mineral portion of stable manure, it is evident from its origin that it must be composed of all the various constituents requisite to the development of vegetable life, and to contain them in a quantitative proportion best adapted to meet the wants of the growing crop. This state of things, though sufficient in itself to justify the most favorable expectations, gives nevertheless, no full exposition of all the virtues of this valuable part in stable manure. There are besides, two other instances to be mentioned which add materially to its efficiency as a fertilizer, and secure to it its acknowledged superiority over all other mineral compounds that have been brought in competition with it. The one relates to the particular form, the other to the state of association in which the mineral part exists in the great mass of stable manure; both acting most powerfully in promoting its assimilation by the plants. For being, as to the first instance, only a small integrant part of the whole voluminous mass of the manure, it must necessarily exist there in a state of indefinite fineness and subdivision, and therefore, most liable to yield to the action of solvents. And if we ask what solvent should probably most powerfully act on the constituents of the mineral portion of stable manure, we must, according to the results of practical experiment, answer in favor of water impregnated with carbonic acid, the very substance which is furnished by the second instance, that is, in consequence of the intimate connection of the mineral matters with the organic part of stable manure. The humus, as we know, provides during the whole course of its decay, for a regular source of gaseous carbonic acid, which, in the moment of its being evolved from it, is most liable to become incorporated with the water contained in the soil, and thereby to impart to it the power of dissolving freely the earthy substances of which the mineral portion of the manure is composed.

These conditions demonstrate at once the highly fertilizing properties of the mineral portion which, in its connection with the organic part, in the form of stable or barn-yard manure, must really offer the most natural and efficient means for restoring fertility to soils. No temptation, however ingeniously displayed, should induce the farmer to lessen his appreciation of this invaluable fertilizer. He should aid, improve and increase it by all means, but never neglect or distrust it, for it is his nearest and best friend on whom he can call in his hour of need, and who will give him not grudgingly increased crops, and impart increased fertility to his soil.—Let not foreign manures of any sort, nor those *manufactured* at home, however pompously advertised or extravagantly puffed, be substituted for it.

Stable and barn-yard manures must be the main dependence of the great body of our farmers. Do not then let it be neglected. Treat it as I have shown above, and there will be less reason for our farmers to submit to the extortions of foreign or domestic manure dealers.

Peruvian Guana stands, as to composition and character, next to stable manure, particularly to that which is in an advanced state of putrefaction. It contains but a small quantity of humus, the whole of its organic part, amounting to 50 per cent., consists of nitrogenous compounds, capable of yielding, in the course of putrefaction, about one-third of their own weight of ammonia.—The balance being about 40 per cent. of mineral matters, mostly phosphate of lime, and 10 per cent. of water. This composition shows at once the article to be a highly concentrated manure; it is, in fact, the most concentrated of all fertilizers of commerce; and practice has long since given abundant evidence in its favor. I have repeatedly spoken of Peruvian guano in my former reports, as to its composition and the particular substances on which its fertility depends; this I need not here repeat and will only refer for information on this subject to my former reports. The collection of more numerous facts and the results of more experience, however, induce me to make some remarks as to its mode of application and the *quantity* which should be used.

This is the more necessary as some of the sources from which our farmers seek information are dealers in the article, and are therefore not disinterested, even if they were from practical experience or scientific knowledge competent advisers. This is not the case, and we therefore have ignorance and selfishness combined to mislead the farming community in the use of this article.

With regard to its application, it must be urgently recommended; first to use an article which is either originally in a state of fine comminution, or rendered so previous to its application, by sieving and subsequent pounding of the selected lumps; and, secondly, to sow it in a manner which will secure its distribution throughout those parts of the soil *where* the grain is sown; to effect this purpose, it on grain crops should always be sown with a drill. It is apparent that Peruvian guano, on account of its containing nitrogen not alone in the most concentrated state, but also in a form (that of the volatile ammonia) which renders it extremely volatile, is more liable to loss than any other of the manures commonly used; and that, therefore, our particular attention should be directed to the ways and means by which its full effect may be secured. To this end, a variety of substances has been proposed for admixture with the guano, and among them especially plaster of Paris. I do not know from what source this recommendation was derived; but the fact is that this substance is extensively used by farmers with the certain belief that its action on the guano is always most beneficial in preventing any escape of ammonia from the same. This is, however, altogether a mistake, and the more necessary to correct, as such a belief may induce the farmer to neglect the taking of other measures which really serve the purpose.

Plaster of Paris, as we know, can only act in the manner above ascribed to it, when a sufficient quantity of water is present to bring its chemical affinities into action; in this case, plaster of Paris exchanges its constituents with those of the volatile carbonate of ammonia, arising from Peruvian Guano, and the result is the formation of sulphate of ammonia, a salt which really contains the volatile element in a fixed combination. In the dry state, on the contrary, plaster of Paris will exercise no influence whatever in fixing ammoniacal compounds, my own practical observation showing that the quantities of ammonia which escape from dry guano amount to the same before and after its admixture with plaster of Paris—and this is exactly the state of things in a dry mixture of plaster of Paris and Peruvian Guano. If it should be advisable to use plaster of Paris along with Peruvian Guano, and this is, indeed, *very* often the case, we have to expect from such an admixture no other material action but that to meet certain deficiencies in the soil which Peruvian guano *alone* cannot supply. Another substance which has been proposed is common sulphuric acid. This substance, however efficient it may be in binding and retaining the ammonia, is not alone costly and inconvenient to handle, but will act, besides, injuriously on the mechanical condition of the guano. It bakes it, forms it into lumps of smaller or larger size, and thus renders it unfit for being properly sown. There is, in fact, but one substance which, if properly mixed with this guano, will in every respect answer the purpose in question, and this substance is soil itself. It has already been remarked that water which has been saturated with ammoniacal salts, if suffered to filter through soil, runs off clear without the ammonia formerly contained in it, and that this power of soils, of retaining the ammonia, has to be attributed to the presence of portions of double silicates in them. This power of soil comes here into action, and it is plain in itself that its effect on the guano will be the more thorough and full the more uniformly the guano has been distributed throughout its mass. In order to attain this object, it may be advisable to mix the guano, previous to its application, with a suitable quantity of soil, (about double its weight,) especially in the case when the quantity of Peruvian guano to be used is too small to allow its uniform distribution over the surface of the acre to be manured. The soil best adapted for this purpose should be a loose, loamy one, and rich in humus, so as to secure to it a specific gravity, not exceeding that of the guano to be mixed with it; a perfect mixture of two substances being possible only when they are of equal specific gravity, and only in this case they will not separate from each other when being sown.

The second point to which I shall direct the attention of farmers, is to the quantity of guano which should be applied per acre, my own practical observation, as well as that of many others who followed my advice, has decided that it should not go beyond two hundred pounds, but may for many soils, according to their degree of stiffness, fall short of one hundred pounds.

It has ever been my endeavor to diffuse amongst farmers the true philosophy of farming, and to make them understand that crops cannot profitably be increased by enormous additions of Peruvian guano, nor of any other manure, as has been advised. This law is correct, that the yield of crops is not in direct ratio to the quantity of any substance either originally existing in the soil or applied to it by a manure, but on a proper proportion of all the elements of the food of plants. Crops cannot, therefore, be economically produced by the application of three or four hundred pounds of Peruvian guano, as has been recommended by some who assume to direct agricultural improvements, without either practical experience or scientific knowledge. If we go beyond a certain quantity, the crop will not be increased in proportion to the expense of the surplus added, and this large application will consequently be unprofitable, save to the manure dealers. The application of 200 pounds of Peruvian guano, *containing compounds capable of forming sixteen per cent. of ammonia*, is enough for any soil, and on many soils a less quantity is all that is required; and the effect of this, if used according to the directions which we have given, will equal in effect double or treble this quantity improperly applied.

This advice has heretofore saved thousands of dollars to the farmers and planters of our State, and if followed will save many more thousands. They should not make up for *other deficiencies* in the soil by the application of large quantities of a manure so expensive as Peruvian guano.

Nitrate of Soda.—This manure has been but little used in Maryland, but wherever it has been applied according to directions given in my former Report, it has fully met all that could be expected of it. As we have no new facts to communicate in relation to its use, I refer to what was said of it in my fourth Report.

PHOSPHATIC MANURES

Of bone black, bone dust and Mexican guano, we have fully treated in the fourth Report made to the House of Delegates, and of these we have nothing new to add, and refer for all necessary information in regard to them to that Report. For the present it is deemed necessary to give the following additional information on other manures of this class.

Columbian Guano.—This is a new variety of phosphatic guano, recently introduced into our market, and presents itself in the form of irregular, stony lumps, apparently composed of two distinctly different parts, viz: of an "exterior layer," only a few lines in thickness, and of the "body, the great mass of the rock" itself, directly underlying the exterior part and extending to the centre of the mass. The former is of a gray or dirty white color, with vitreous lustre, hard but brittle, and therefore easily ground in a mortar; the interior part is of a dark brown mottled color, without any lustre, tough, horny and tenacious as to texture, and only with difficulty reduced to powder.

A proper chemical examination of this substance is therefore naturally divided into two separate analyses, that of the exterior layer and that of the body or great mass of the rock; the latter representing at the same time the composition of the genuine commercial article.

Several carefully conducted analyses resulted in the following composition of the respective parts:

	Exterior Layer.	Body of Rock.
Lime	41.76	39.01
Magnesia	3.10	0.22
Peroxyd of iron	0.34	0.11
Phosphoric acid	39.92	43.50
Calcium	1.34	——
Fluorine	0.85	——
Chlorine	0.75	trace
Soda	1.61	——
Sulphuric acid	2.07	7.08
Water and organic matter	8.60	10.75
Sand	0.02	0.02
	100.36	100.69

The relative proportion of the different constituent substances, above given, necessarily leads to the following state of their combination:

EXTERIOR LAYER.

Tri-phosphate of lime		77.71
containing of lime	41.76	
containing of phosphoric acid	35.95	
Tri-phosphate of magnesia		6.77
containing of magnesia	3.10	
containing of phosphoric acid	3.67	
Phosphate of iron		0.64
Fluoride of calcium		1.76
Chloride of calcium		1.18
Sulphate of soda		3.68
Water and organic matter		8.60
Sand		0.02
		100.36

BODY OF THE ROCK.

Common phosphate of lime		82.48
containing of lime	34.04	
containing of water	5.44	
containing of phosphoric acid	43.00	
Common phosphate of magnesia		0.66
containing of magnesia	0.22	
containing of water	0.05	
containing of phosphoric acid	0.39	
Phosphate of iron		0.22
Sulphate of lime		12.05
containing of lime	4.97	
containing of sulphuric acid	7.08	
Water and organic matter		5.26
Sand		0.02
		100.69

It will be seen from the above that in both parts of the rock the phosphoric acid is present in the form of a tribasic phosphate, (containing three atoms of base to one atom of acid) with the difference that in the "exterior layer" the three atoms of base are made up by lime alone, thus forming the so-called *tri-phosphate of lime*, whilst in the "body of the rock" only two of them are lime, and the third is water, a combination which is known as *common phosphate of lime.*

In the following we will add a few items which will prove the correctness of this view beyond all doubt:

1. Common phosphate of lime, when exposed to a high degree

of temperature, loses its volatile atom of base, (the water,) and is consequently transformed into a phosphate of two atoms of fixed base, or a pyrophosphate. Triphosphate of lime, under the same conditions, remains unaltered. According to this, the hydrochloric acid solution of the natural, as well as of the heated powder of the "exterior layer," if treated with ammonia, produces a precipitate which is, in both cases, soluble in acetic acid. This is also the case with the natural powder of the "body of the rock," whilst its heated powder, if treated in the same manner, remains insoluble in acetic acid, as pyrophosphates do. But pyrophosphates can only be produced in this way by common phosphates, ergo: the "body of the rock" is composed of common phosphate of lime, the "exterior layer" of triphosphate of lime.

2. Common phosphate of lime, when brought in contact with ammonia, is converted into triphosphate of lime, whilst phosphate of ammonia is found in solution. This fact may explain the relation which exists between the "exterior layer" and the "body of the rock." The latter, we have seen, is composed of common phosphate of lime and some organic matter; on its surface, where it was exposed to rain and to the influence of the atmospheric ingredients, (especially ammonia,) its organic matter became slowly decomposed and ammonia evolved from it. The ammonia thus produced by the organic matter of the rock, as well as that portion conveyed to it by the atmosphere, necessarily came in close contact with the common phosphate of lime on the surface of the rock, and consequently transformed it, according to the above, into the triphosphate of lime, of which the "exterior layer" is composed, whilst the resulting phosphate of ammonia, on the other side, was washed away by the rain.

It was found upon experiment that, on account of the peculiar state of the aggregation of the particles of the rock, liquid ammonia had to remain for a long time in contact with it before appreciable quantities of phosphate of ammonia could be found in solution.

3. If extracts of both parts of the rock in water were treated with an excess of alcohol, that of the "body of the rock" produced a voluminous white precipitate of sulphate of lime, whilst that of the "exterior layer" remained clear, though it produced instantly a precipitate with chloride of barium, after having been acidulated with hydrochloric acid. This is a proof that in the "exterior layer" the sulphuric acid is present in the form of sulphate of soda, whilst the "body of the rock" contains it as sulphate of lime.

Both triphosphate of lime and common phosphate of lime, are equally insoluble in water, and have, in this respect, no advantage over each other as fertilizers; the former is the constituent part of all the natural phosphates heretofore known as guanos, bones, apatite, and the various other mineral phosphorites; the other, on the contrary, was, before this time, only known to chemists as an artificial product which had not been met with in nature. In an agricultural point of view the phosphoric acid furnished by Columbian guano is therefore equal in quality to that contained in all the other natural phosphatic manures; as fertilizers they all will act with the same energy and with the same success, and their commercial value should, therefore, be simply in proportion to the per centage of phosphoric acid which they contain by analysis. This is the more necessary to mention as the Columbian guano has been highly recommended to the agricultural community upon the analyses of several chemists who declared it to be a *natural superphosphate of lime*, and thus ascribing to it all the virtues of this fertilizer. But there is, as we have proven, no preference, whatever, to be attributed to either of them as regards the quality of their constituent parts.

Mineral Phosphorite.—In my last Report I have given the analyses of several lots of this fertilizer that have been sold in this market. The article, however, did not seem to have answered the expectations of the public, and no more was heard of it since. It is most probable that the particular state of aggregation of this mineral locks it too tightly up against the solvent action of water, even if it was calcined and subsequently crushed to the finest powder, and that, therefore, the ill success of a substance so rich in phosphoric acid as the above, has to be attributed to its failure to provide for this nutriment within a certain time when it was wanted by the plants. If this is the case, and no other reason is more plausible, there will be no better plan for making it useful than by decomposing it with sulphuric acid in order to transform it into a superphosphate; a business which must turn out most profitably by the low price at which the article can be had. More recently, a mineral from the State of Connecticut, of the same character as the above, has come to my notice, which is soon expected to be introduced into our market. Upon analysis it was found to be composed as follows:

Triphosphate of Lime	87.98
Chloride of Calcium	1.45
Fluoride of Calcium	9.55
Peroxyd of Iron	0.74
Sand	0.61
	100.33

The quantity of phosphoric acid contained in the above triphosphate of lime is 40.31, or nearly twice as much as 100 parts of raw bones contain. Besides, there is a considerable quantity of fluoride of calcium present, which renders this mineral still more valuable as a manure; fluoride of calcium forming a constituent part of the animal body to which it is supplied by plants.

Superphosphate of Lime.—This is an artificial compound which was originally designed to present to the farmer the constituents of bones in a form ready for assimilation by plants. Bones, as we know, require from their peculiar organic structure, a very long time of exposure before their constituent parts yield to the solvent action of water, and be of direct use as manure; moreover, the difficulty in grinding bones throws another obstacle on their practical application, and generally induces farmers to burn them at the expense of their valuable organic part, in order to secure the more ready action of the remaining phosphate of lime. These evils are, to a large extent, removed by the transformation of bones into superphosphate of lime, and the immense success which this compound has met with from its first introduction till the present day, has opened for it a large field for competition, and has more recently increased the original use of bones over all the natural phosphates of commerce.

Superphosphate of lime is made by adding, under some precautions, sulphuric acid to phosphate of lime (a combination of phosphoric and lime, as contained in bones, Mexican guano, mineral phosphorite, &c., and hence the different materials employed.) As soon as the above ingredients are brought in contact with each other, a brisk chemical action ensues: sulphuric acid, being a very strong acid, and having a greater affinity to lime than phosphoric acid, lays hold at once of a portion of the lime, which exists in combination with phosphoric acid, and forms with it the hydrate of the sulphate of lime, our common plaster of Paris, whilst on the other side the common phosphate of lime, thus deprived of a portion of its lime, is converted into a new compound, called bi-phosphate of lime, which relatively contains more of phosphoric acid and less of lime than the former. Superphosphate of lime is therefore an intimate mixture of plaster of Paris, and bi-phosphate of lime; its valuable properties, however, depend exclusively on the latter constituent, from the chemical character of which we have also to judge of its mode of action as a manure.

Bi-phosphate of lime is easily soluble in water, it contains phosphoric acid in a soluble form; but its most important feature is that, whenever it meets a strong base, e. g. lime, either in its caustic or carbonated state, it becomes reconverted into common phosphate of lime, by uniting again with that portion of lime from which it was formerly separated by means of sulphuric acid. On account of its solubility in water, it will therefore penetrate the soil intimately to which it is applied as a manure; but whilst doing this, it meets almost every where on its way with lime, which in the form of minute and invisible particles is present in, and uniformly diffused through all cultivated soils. The immediate consequence of these circumstances must be the re-production of common phosphate of lime in the very body of the soil itself.

By applying superphosphate of lime to a soil, therefore we reproduce a substance (common phosphate of lime) for the decomposition of which we have gone through all the trouble of the manufacture of the superphosphate; but we reproduce it in such a state of *fineness* and uniformity of *distribution*, as cannot be effected by any mechanical means. A fineness and distribution of a solid substance as are here effected, can *quasi* be considered a state of solution; it is certainly a fact that the substance in this condition cannot exercise any notable resistance to the solvent power of water, especially not, if the water is impregnated with carbonic acid, or ammoniacal salts, as is the case in nature;—it will become dissolved and thus rendered assimilable.

For ready reference I will here repeat that for every 100 lbs. of bones, 29 lbs. of sulphuric acid should be used in order to secure the desired reaction; with regard to its manufacture and the necessary precautions to be taken thereby, I will refer to my third Report, where I have treated on this subject in detail.

Within the last year there have come two articles of superphosphate under my notice; the one manufactured by B. M. Rhodes of Baltimore, (No. 1,) the other by Allen & Needless of Philadelphia, (No. 2,) both being well compounded, and if *made in accordance with the samples* submitted for analysis, and so *guaranteed* to the purchaser, will be of great agricultural value.

		No. 1.		No. 2.
Bi-phosphate of lime (soluble)		24.56		23.36
containing of lime	7.00		6.66	
" " phosphoric acid	17.56		16.70	
Phosphate of lime (undecomp. bone-earth)		2.69		——
containing of lime	1.47		——	
" " phosphoric acid	1.22		——	
Hydrated sulphate of lime (plaster of Paris)		58.80		34.85
containing of lime	19.19		11.37	
" " sulphuric acid	27.33		16.20	
" " water	12.28		7.28	
Sulphate of ammonia		——		5.77
containing of sulphuric acid	——		3.50	
" " ammonia	——		2.27	
Sulphates of soda and magnesia		——		10.81
containing of sulphuric acid	——		6.08	
Sand and peroxyd of iron, organic matter and moisture		13.95		25.21
capable of producing of ammonia	——		1.47	
		100.		100.

CALCAREOUS MANURES.

In my previous Reports this class of manures has been so fully described and their mode of action so thoroughly explained, that I deem it unnecessary to repeat here what I there said of them; the more is this unnecessary that in the particular description of soils the kind of lime and mode of applying it is specially recommended. I shall therefore only mention in this place gas-house lime, give its analysis, and a few suggestions as to its use. I do this because inquiries have of late been frequently made of me in relation to it. The following is an analysis and report of the gas-house lime sold in Baltimore by B. S. Holt, and delivered on board of vessels at any wharf for five cents per bushel:

At your request I selected a specimen of the gas-house lime which you sell, in order to procure a sample that might not be liable to the objection of being unfairly taken. The examination was undertaken to determine the fitness of this article for agricultural purposes.

I herewith forward you an analysis of the sample taken, and also some practical information for the use of this variety of lime. The analysis of a sample of gas-house lime shows its composition to be as follows:

Per centage composition of Gas House Lime.

Hydrate of lime, (water-slacked lime,)	41.17
Hydrate of magnesia	1.02
Carbonate of lime, air-slacked lime,)	28.48
Hydrated sulphate of lime, (plaster of Paris,)	4.93
Hydrosulphate of sulphuret of calcium,	3.79
Hydrosulphate of sulphuret of iron,	4.67
containing of sulphureted hydrogen, 5.03	
Phosphate of lime, (bone-earth,)	0.26
Sand	2.94
Water	12.74
	100.

By reference to my first Report to the House of Delegates of Maryland, you will perceive that I then published the result of several examinations of this lime, and recommended its use under certain conditions. Since that time I have carefully watched the effects of this lime, and collected all the facts attending its application, and am confirmed in the belief, that not only is this lime free from injurious effects, when properly used, but that on certain soils it is preferable to every other variety.

It can be properly used wherever oyster shell lime or stone lime, free from magnesia, is indicated; and moreover, is especially applicable to all soils where plaster of Paris can be beneficially used.

By the use of this lime, the purchaser will have all the good effects of ordinary lime, and at the same time, save the expense of the cost of plaster as an addition to the soil.

The mode in which this lime should be applied, depends on its peculiar properties resulting from its composition, which is constantly changing on account of the presence of the hydrosulphates of lime and iron in it. These substances cannot long exist under the influence of atmospheric air, and are finally converted into sulphate of lime, (plaster of Paris,) and peroxyd of iron. The quantity of sulphate of lime which is contained in this article, indicates to what extent this process of decomposition has already advanced, and which, of course, will be quickened when the lime is scattered and exposed to the full influence of the atmosphere. Besides these substances, we meet with a large per centage of water-slacked lime, which also undergoes a change under the influence of the atmosphere, being converted into air-slacked lime. 100 parts of this lime will therefore eventually become converted into 72.87 parts of air-slacked lime, and 30.13 parts of plaster of Paris; the other substances as given in the analysis remain unchanged.

This lime should therefore be applied to the surface in the fall, suffered to remain there, and then turned in in the spring, for any summer crop; or it may be applied on the surface in the spring, and turned in in the fall, for a wheat or any other winter crop. In this way no possible damage could happen from its use; on the contrary, reliable gentlemen have informed me that they have experienced most excellent effects from it when used in this way. There is another valuable effect of this lime not possessed by any other, which is its tendency to destroy insects.

I have been informed of many applications of gas lime, always with beneficial effects when applied properly, and here insert a note from a gentleman who has extensively used it in Anne Arundel county:

DR. JAMES HIGGINS,

Dear Sir:—In compliance with your request, I would briefly state my experience as to the application of "Gas House Lime" upon my land in Anne Arundel county.

I put at the rate of from 50 to 60 bushels of lime per acre upon the sod of old worn-out land and plowed it down, and with the application of guano and salt agreeably to your directions, (after analyzing the soil,) I made a fair crop of oats and corn. The entire breadth sowed in oats had the benefit of the lime, but not so with my corn crop, a portion of which was not limed, and that portion was distinctly marked by the pale color of the corn during summer, and the inferiority of the crop at maturity.

Very truly yours,
L. W. GOSNELL.

Mr. Gosnell applied his lime in the spring with the effect which is seen above. This lime has also another valuable property, it secures crops from the ravages of insects of all kinds, and I would here suggest the propriety of its use on those wheat lands that are liable to be troubled with the wire-worm. Should it prove as efficacious against them as against other insects, a compound can easily be made to secure the farmer from their ravages. The above report was made in 1854, and since then I have seen a statement substantiating what I then said of it as to its destructive influence on insects which are injurious to vegetation.

There has also come under my observation the anlaysis of eight different samples of Schuylkill lime. As this lime is extensively used by many of our farmers in Maryland, I here subjoin a copy of the analyses. These analyses show the uniformity of the quarries, and are a good guarantee of the uniform magnesian quality of the lime from this source. Large quantities of it are used, about 70,000 bushels per week being manufactured at the kilns of Robert & Wm. Mogee of Wilmington, Delaware.

Analysis of eight samples of "Norristown Limestone," from Wm. & Robert Mogee, Esqs., of Wilmington and Norristown, Pa. The samples of "Norristown Limestone" were taken on the Schuylkill, 15 miles from Philadelphia, Pa.:

	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8
Carbonate of lime..........	53.6	50.5	47.5	45.2	53.6	54.2	53.7	53.8
Carbonate of magnesia.....	42.4	44.7	42.8	41.0	43.9	43.8	43.3	43.4
Sand and Clay.............	4.0	4.8	9.7	13.8	2.5	2.5	2.5	2.8
	100.							

One hundred parts of the above limestones will yield therefore, when burnt, of:

Caustic lime, (quick-lime,)	30.0	28.3	26.6	25.4	30.0	30.3	30.1	30.1
Caustic magnesia...........	20.4	21.5	20.6	19.7	20.9	20-6	20.9	20.7

and will consequently produce of:

Water-slacked lime.........	39.6	37.3	35.1	33.5	39.6	40.1	39.7	39.7
Water-slacked magnesia...	29.5	31.0	29.7	28.4	20.3	29.9	30.3	30.0

MISCELLANEOUS MANURES.

Gypsum—Common Salt.—We comprise these two manures under one head; not that they are similar either in their composition or mode of action, but because there is no very appropriate class to which they can be referred; and they act more as *mediums* than as direct nutriments.

Gypsum in its pure state is composed as follows:

Lime..	33	per cent.
Sulphuric acid..............................	46	"
Water	21	"

Experience has determined that the crops on which it should be used are those only which have a large surface of leaves, such as clover, beans, peas, cabbage and tobacco, and is best applied to clover, peas, beans, cabbage and tobacco when their leaves first begin to expand; on corn it should be used just when the *silk* begins to form. On wheat, timothy, oats, &c., its beneficial action is not so clearly manifest as on the crops which I first mentioned.

Very much has been said with regard to the theory, i. e., the philosophical explanation of the way, or *ways*, in which plaster acts. On this subject I can but say that the beneficial influence of plaster on leguminous plants must be explained in some other way than that of its affording them *direct* nourishment by the assimilation of its constituent parts. Sulphuric acid is, as a *direct nutriment*, less essential to clover and others of its class on which it best acts, than to other classes of our cultivated plants, as they contain the smallest amount of compounds united to sulphuric acid, and also less of sulphur; as to the influence of its other constituent, lime, it is present as a *nutriment* in sufficient abundance in nearly every soil, and moreover, plaster acts well, and sometimes best, on those soils which have been heavily limed or which originally contain the largest amount of calcareous matter. Its beneficial action must therefore be explained by the relations which it bears to ammonia. It is certainly known that plaster of Paris *when dissolved* exercises an attractive influence on carbonate of ammonia, and by a transposition of its elements fixes it, by forming sulphate of ammonia. This action is however reversed in the dry state, for a mixture of sulphate of ammonia and carbonate of lime will evolve carbonate of ammonia.

Now clover and the other crops which I have mentioned are famous for the large extent of their leafy surface, and derive most of their *nitrogen by assimilating it through their leaves*, leaving the soil richer in this substance than before these crops were produced. Clover and all the plants of this class therefore obtain most of their organic nutriment through their leaves. Plaster, therefore, being sown on these leaves, and the weather being moist or dew being in sufficient quantity to dissolve it, will at once *fix* the ammonia of the atmosphere, and the leaves will take it up and carry it throughout the whole organization of the plant.

This view of the action of the plaster is strengthened by the known facts in relation to its utility. If plowed in the soil, it never produces the same effect as when sown broad-cast. It does not act so well on plants which have but a small leafy surface as on those which have that surface very extended. It has no action in dry, windy weather. It does not act when mixed in the soil on moist land, which shows that its want of action in dry, windy weather is not due alone to its not being dissolved.

Furthermore, and I deem this conclusive as to the views which I have given above; soils may contain a sufficiency of plaster to meet all the wants of the crop, and yet the particular class of plants which I have above enumerated will be much benefited in particular seasons by having plaster sown broad-cast over them.

When sown broad-cast it adheres to the surface of the leaves, and being dissolved by dew it fixes the volatile carbonate of ammonia of the atmosphere, which is taken up by the leaves, and this explains fully all the phenomena of its beneficial action. This, though a novel, yet I think is a correct explanation, at least it more thoroughly explains the well known facts attending the action of this substance than any other view which I have seen taken of it.

Common Salt.—The *mode* of action of this substance is uncertain as yet, but experience has shown that it is a very useful application on all soils that have a tendency to produce crops of wheat liable to be *straw-fallen.* It gives a clean, strong straw, increases the weight of the grain, and imparts such vigor to the crops on which it should be used as to render them much more free from loss by attacks from insects or by unfavorable weather, than otherwise they would be. It also acts as a manure by dissolving the phosphate of lime which may exist in the soil, and thus rendering it available to plants.

ARTIFICIAL MANURES.

The high price of crops, and an energetic spirit of improvement, have caused a demand for many other manures than those formerly used, and to meet this demand, manufacturers have introduced into our markets various compounds.

These have been recommended to the use of the farming community by recommendations from practical men who have used them, and have been endorsed, *without qualification*, by some "scientific men." I cannot too strongly caution farmers to beware of these manures, unless with a written guarantee as to the quantity of their several constituents. There are at present manures extensively sold in our markets at a price very far above their real value, which could not be obtained if farmers were correctly informed in relation to them. Compounds under names and with certificates calculated to deceive the public, are now so prominently advertised by means of pamphlets and the commercial and agricultural press, that great caution is necessary in order to avoid deception. It will be well for farmers before being led away by certificates of the superiority of any manure over "best Peruvian guano," or equal mixtures of "best Peruvian and best Mexican," to ascertain if these guanos came from the same parties as sold the manure, and whether they were *really* what they assumed to be. The business of making artificial manures is profitable in proportion to the amount of fraud practiced in it, and unfortunately, professed men of science have furnished their official position and name to the recommendation of manures, and thus have become aids to gross imposition on the purchaser. Again, I say to all, beware of them, unless accompanied in every instance with a written guarantee as to the per cent. of ammonia, the per cent. of phosphate, and the per cent. of bi-phosphate of lime they contain.

There are manures sold in the Baltimore market under the name of "Superphosphate of Lime," which on analysis contain not three per cent. of that article; as well might one call a coin a silver coin which only contained three per cent. of silver. There are manures also sold here the chief materials of which are bought in Baltimore, thence carried hundreds of miles to be *manufactured*, and then again brought back and sold to our farmers. Do they not have to pay thus double freight on these manures, and then trust to both the honesty and intelligence of a manufacturer for their purity and goodness? Manure dealers of this class can afford to advertise largely, for their profits are great, and although their manures may be heralded to the agricultural public as superior to the best Peruvian guano, or as superseding it, yet such cannot be the case except *in very rare instances.* They are sold at a price above their value, and farmers will find to their cost, when it is too late for redress, that they have been induced to part with their hard earnings for comparatively worthless articles. I speak more particularly of this class of manures in this Report, as some of the press have refused to publish articles condemning them, and some of them are presented to the public under circumstances well calculated to deceive it.

When an analysis shows the per centage of ammonia, not "ammoniacal salts" or "compounds containing ammonia," as sometimes is given in analyses, and when it shows the per centage of bi-phosphate or superphosphate of lime, and also the per centage of bone-earth, or common phosphate of lime—and no manure should be bought unless the per centage of these substances ls clearly set forth in the analysis and the purchaser *guarantees* them to be present in the *quantity* named—then the calculation of the value of a manure can be made by any one familiar with the common rules of arithmetic, by attending to the following facts and directions: Suppose a manure is offered for sale which analysis shows to be composed of three per cent. of ammonia, twenty per cent. of superphosphate or bi-phosphate of lime and five per cent. of bone phosphate of lime, what is its value? The calculation to discover this is as follows: The three per cent. of ammonia will in a ton of 2,000 lbs. amount to sixty pounds. Ammonia at the rate at which it sells in Peruvian guano, as yet the cheapest source of its supply, can be procured for about twelve cents per pound.

The quantity of ammonia in this article then in the ton is worth seven dollars and twenty cents.

Twenty per cent. of superphosphate of lime in a ton will make the absolute quantity of four hundred pounds, which is worth nine cents per pound. This, then, for the four hundred pounds in a ton would be worth thirty-six dollars; the bone dust or bone phosphate of lime which may remain in the manure undecomposed is worth two cents per pound, and the six per cent., being equal to 100 pounds in the ton, is therefore worth two dollars. The whole value of a ton then is stated as follows:

Ammonia	worth	$7.20
Bi-phosphate of lime	"	36.00
Phosphate of lime	"	2.00
These together are worth		$45.20

I have been the more careful to speak at length on this subject, and to give a rule by which farmers may save themselves from imposition, because it is apparent to me that very strenuous efforts are being made to induce a large consumption of artificial manures during the present year. Again I say to farmers and planters, do not buy these manures, unless on the condition which I have above named.

We have now given, to the best of our ability, a full, clear, and we trust a correct description of the various manures for improving the texture and supplying the nutrient substances in soils. In this we have been guided solely by a desire to give the fullest and most exact information on all the subjects of which we have treated. We have been willing pupils in the lesson taught by the experience of practical men, and ardent learners from those which science inculcates; the results of those two, to the utmost extent of our ability, we have embodied in the foregoing pages, and should they instruct any one farmer to follow a more rational system than that which at present is followed, we will be fully rewarded. Let but one man in a neighborhood practice the true principles of farming, and others will learn by his example what they will not receive from theory. These in turn will become teachers, and others will learn from them. "A pebble once cast into the deep waters of knowledge, no jealous hush can again still their disturbed bosom, but as the wavelets spread and the circles widen, the joyous shores will receive their hallowed kiss and echo in gladness the tribute due to Nature's everlasting truths."

We have spoken of different manures, their composition, their mode of action, the manner in which, and the crops to which they should be applied. In this we have freely garnered from every reliable source, and have given the results to the agricultural community. In speaking of the mode of action of different manures, we claim originality for one very important point, the explanation of the manner in which stable manure and green crops act when plowed in. I feel it due to the office which I hold, to state that its occupant, to the best of my knowledge first pointed this out, I mean the agency which green crops and stable manure have in improving the soil, not only by reason of the directly nourishing substances which they contain, nor by their improving the mechanical texture of the soil, but also by their decomposition in affording carbonic acid, which, by its solution in water, makes it a very active solvent of the mineral constituents of a soil, and thus places them in a state of ready assimilation by plants. Baron Liebig, the father of Agricultural Chemistry, the greatest and ablest agricultural chemist of the present day, in his last work, a model of sound philosophy and pre-eminent ability, speaking of the beneficial influence of humus or decaying vegetable matter, says: "To the action of humus, (decaying vegetable matters,) as a solvent for phosphate of lime and earthy carbonates, I first drew attention in 1851 in my 'Chemical Letters,' page 625, 3d German edition." (See Principles of Agricultural Chemistry with special reference to the late researches made in England by Justus Von Liebig. New York, 1855.) Allowing, as we must do, the truth of this to the fullest extent, we yet can show that this fact, of vast importance in agricultural science and corresponding benefit in practice, was clearly and distinctly set forth in my first Report to the House of Delegates, written in 1849, and printed in 1850. In that report, speaking of the influence of decaying vegetable matter, (humus,) I said, "Its use is now restricted to giving the necessary degree of porosity to stiff compact soils, and by its decomposition to render rain-water or dew better solvents of the *mineral* constituents of the soil." And again, "Vegetable matter contains a large proportion of carbon, (charcoal,) which, on exposure to the air is changed into carbonic acid. Water impregnated with this substance, has the property of powerfully dissolving all the minerals in a soil, and by this means rendering it more productive." See First Report of State Chemist to House of Delegates. House Doc. G., p. 8.

Should this fact have been made known by any one else prior to its being taught by me, none will more readily acknowledge the honor due to its discoverer than myself. Baron Liebig claims 1851 as the date of his enunciation of it; I show that it was promulgated to the world, by means of my first report and the copying of it by the press, in 1850; should any one show a prior date, the honor therein is due to him as to priority of discovery.

In the foregoing pages, the means which conduce to the improvement of the soil, either by changing the form of the substances which already exist in it, or by adding those which may be deficient, or altogether absent, have been pointed out. We have not spoken of the utility of draining nor the influence of good cultivation, as these matters of themselves would take up more space than is allowed in this Report.

There is another way in which soils recover their lost fertilizing agents, which has not heretofore been mentioned, and which shows in a most distinctive manner the provident care of Him who "makes our fields to rejoice with corn," and who even in *apparent* afflictions "yet worketh for our good." The increased solubility of the mineral substances in a soil, by the addition of manures or by means of cultivation, would tend eventually to render them barren and unproductive, unless the substances requisite to crops should be applied to them artificially, and this would be attended with immense labor and expense, such as could not be incurred by the husbandman. Early lessons had implanted in my mind that "God worketh all things for our good," and having, in my professional duties, my attention directed to the disastrous effects of droughts on the crops immediately subject to their influences, (and who has not seen them?) I sought to discover of what utility they were, and in what way they could become witnesses in favor of the general law which I have above mentioned. Experiments in the laboratory, and observations in the open field, at length enabled me to demonstrate the mode of their beneficial action, and I submitted to the public the result of my investigations in the following communication to them:

Ultimate Benefits of Droughts, and the Mode in which they Act to Improve Land.

It may be a consolation to those who have felt the influence of the late long and protracted dry weather to know that droughts are one of the natural causes to restore the constituents of crops and renovate cultivated soils. The diminution of the mineral matter of cultivated soils takes place from two causes:

1st. The quantity of mineral matter carried off in crops and not returned to the soil in manure.

2d. The mineral matter carried off by rain water to the sea by means of fresh water streams.

These two causes, always in operation, and counteracted by nothing, would in time render the earth a barren waste in which no verdure would quicken and no solitary plant take root. A rational system of agriculture would obviate the first cause of sterility, by always restoring to the soil an equivalent for that which is taken off by the crops; but as this is not done in all cases, Providence has provided a way of its own to counteract the thriftlessness of man, by instituting droughts at proper periods to bring up from the deep parts of the earth food on which plants might feed when rains should again fall. The manner in which droughts exercise their beneficial influence is as follows: During dry weather a continual evaporation of water takes place from the surface of the earth, which is not supplied by any from the clouds. The evaporation from the surface creates a vacuum, (so far as water is concerned,) which is at once filled by the water rising up from the sub-soil of the land; the water from the sub-soil is replaced from the next stratum below, and in this manner the circulation of water in the earth is the reverse to that which takes place in wet weather. This progress of the water in the earth to the surface manifests itself strikingly in the drying up of springs, and of rivers and streams which are supported by springs. It is not, however, only the water which is brought to the surface of the earth, but also all that which the water holds in solution. These substances are salts of lime, and magnesia of potash and soda, and indeed whatever the sub-soil or deep strata of the earth may contain. The water on reaching the surface of the soil is evaporated and leaves behind the mineral salts, which I will here enumerate, viz: Lime, as air-slacked lime; magnesia, as air-slacked magnesia; phosphate of lime, or bone earth; sulphate of lime, or plaster of Paris; carbonate of potash, and soda, with silicate of potash and soda, and also chloride of sodium, or common salt. All these are indispensable to the growth, and production of plants which are used for food. Pure rain water *as it falls* would dissolve but a *very* small proportion of some of these substances, but when it becomes soaked into the earth it there becomes strongly imbued with carbonic acid from the decomposition of vegetable matter in the soil, and thus acquires the property of readily dissolving minerals on which before it could have very little influence.

I was first led to the consideration of the above subjects by finding, on the re-examination of a soil which I analyzed three or four years ago, a larger quantity of a particular mineral substance than I at first found; as none had been applied in the meantime, the thing was difficult of explanation until I remembered the late long and protracted drought. I then also remembered that in Zacatecas and several other provinces in South America, soda was obtained from the bottom of ponds, which were dried in the dry, and again filled up in the rainy season. As the above explanation depended on the principles of natural philosophy, I at once instituted several experiments to prove its truth.

Into a glass cylinder was placed a small quantity of chloride of barium, in solution; this was then filled with a dry soil, and for a long time exposed to the direct rays of the sun on the surface. The soil on the surface of the cylinder was now treated with sulphuric acid, and gave a copious precipitate of sulphate of baryta.

The experiment was varied by substituting chloride of lime, sulphate of soda, and carbonate of potash, for the chloride of barium, and on the proper re-agents being applied in every instance, the presence of those substances was detected in *large* quantities on the surface of the soil in the cylinder. Here then was proof positive and direct, by plain experiments in chemistry and natural philosophy, of the agency, the ultimate, beneficial agency, of droughts.

We see, therefore, in this, that even those things which we look upon as evils, by Providence are blessings in disguise, and that we should not murmur even when dry seasons afflict us, for they too are for our good. The early and the latter rain may produce at once abundant crops, but dry weather is also a beneficent dispensation of Providence in bringing to the surface food for future crops, which otherwise would be for ever useless. Seasonable weather is good for the present, but droughts renew the storehouses of plants in the soil, and furnish an abundant supply of nutriment for future crops.

I am happy to state that Prof. Henry of the Smithsonian Institute has fully endorsed the above views.

If the effect of this had only been to teach men patience under seeming evils and to add another proof to the goodness of our Creator, I should have been amply rewarded for all sacrifices that I have endured in my present position. If I could teach mankind to be patient under present evils, in the certain anticipation that they will bring to them ultimate good, then would I be contributing much to the cause of human happiness. Apart from this view of the case, however, the above facts have a great practical bearing on the operations of farming. In soils that have an impervious sub-soil, and from which the water runs off and does not soak through, it is apparent that no benefits can arise from droughts; if the water does not soak through a sub-soil in wet, it cannot arise in dry weather, and this being the case, nothing can be brought up from below; the cultivators of such soils will endure all the evils of drought on present, and derive no benefit from them on future crops. He therefore is taught to loosen and break up those impermeable sub-soils by means of draining, deep plowing, and sub-soiling when these sub-soils contain nothing injurious to vegetation. It teaches the cultivator of the soil that he should so prepare it as to reap the advantage of his labor in a good season, and when a drought comes, he will be comforted by the reflection that its future benefits will compensate him for all his present losses

I proceed now to give a description of the counties visited by me since my last Report to your honorable body, the analyses of their different soils, with the best and most economical mode of improving them, their natural resources for agricultural improvement, their industrial resources and such other matters as may have any relation to their development and improvement.

FREDERICK COUNTY.

I feel it due to myself to state that when I first went to the examination of this county, I caused the fact to be announced in all the papers published in it, and moreover stated my readiness and willingness to attend to any request from its farmers who might need my services for special examinations, and informed them where I could be found and where specimens of lime-stones or soils should be sent for analysis. I moreover caused to be published in all the papers proper directions for taking samples of soil. Every specimen of soil that was sent to me, save from two persons, has been examined and the Reports sent to their owners; these two I shall examine and report on at some future time. They were not done heretofore for reasons which will be satisfactory to those who sent them. During my protracted residence in this county, many examinations have been made of all the different varieties of its soils and of all the varieties of its limestone. Lectures were delivered in the county in such number and places as I was told were best calculated to insure good audiences. The attendance at these showed the interest which was manifested in my labors. The meetings were much larger than any political gatherings of either side, save the "mass meetings," though these latter were made by the active exertions of political parties in times of high political excitement. The approbation manifested was such as to satisfy one of much greater vanity than myself. Let the advice which I hereafter give be followed by the farmers of this county, and they will admit that they have received an hundred fold for all the expenses which they may have incurred. I make this statement only in self-defence. Let none complain but those who, having sought, have been refused my services, and I shall be scatheless.

Whether we regard the number of the population, the richness and value of the sources for improving the soil, the fertility of the soil itself, or the quantity of its agricultural productions, this county must be regarded as the empire county of the State

It is bounded by the Pennsylvania line on the north, the Potomac River on the south, by Washington county on the west, and by the counties of Carroll and Montgomery on the east. It is divided into three natural geographical divisions. First, and most westerly, that part embraced between the Catoctin and South Mountains, which includes the Middletown Valley on the south, and Harbaugh's Valley on the north. Secondly, that part of the county lying between Catoctin Mountain and the Monocacy River. Third, that part lying between the Monocacy River and the Eastern border of the county. The division of the variety of soils does not strictly correspond with this geographical division, and these I must classify according to the local names by which they are called in the neighborhood and the rocks from the decomposition of which they are composed. By the former the people of the county will have a clear comprehension of my meaning in referring to these soils. By the latter they will know their general composition, and appreciate the directions for their proper mode of treatment.

MIDDLETOWN VALLEY SOILS.—Before going into a description of these, I would be doing injustice to the beauty of this valley, if I did not speak of its scenery, and I shall not attempt to do it justice by a description of it. All that can gratify the eye or conduce to our pleasures in contemplating the beautiful in nature is unfolded. in it. The truest and most exact picture of it would show real beauties, such as poetry describes in its wildest fancies, or the imagination paints in its brightest pictures. The soils of this valley are mainly, if not entirely, composed by the degradation of mica slates or shales, and the rocks known by the name of epidote. The former includes all the middle part of the valley; the latter the soils on the slopes of the mountains. There is, of course, a third class existing where these two unite, and which partakes most of the character of either as one or the other predominates. Mica-slate has the following composition, and the fundamental constituents of the soil, those mineral substances which form its great mass or body, will therefore exist nearly in the following proportions:

Silica or Sand	77.00
Alumina Oxyd of iron	17.00
Lime and magnesia	4.00
Potash and Soda	2.00

Specimens from near Jefferson, from the neighborhood of Petersville, from near Burkittsville, near Middletown, and various other places in this valley, exhibited very much the same composition.

The nature of the separate elements which compose this mica-slate, is such as, on being decomposed, will form a compact, strong clay soil, well adapted to the growth of wheat and grass, and also of corn: indeed, soils formed from this species of rock, when thoroughly disintegrated, have every where been famous for their productiveness. When not fully decomposed, these soils are not fertile, not because they do not contain the substances necessary to fertility, but because these substances are not in a condition, as to solubility, for of being absorbed by the plant.

If then this variety of soil be not productive, if it does not fully compensate for the labor bestowed on it, we must use such means and appliances as will set free the substances which it contains. If there be defect in its texture, then the same means must be used; fortunately there is one that serves both purposes here. The soils of this valley can, in every instance, as far as I have examined them, be materially improved by the addition of water-slacked in lime, with the exception hereinafter mentioned.

The following is the report of an analysis made of a specimen taken from the farm of Dr. Marlow, on the Merrie land tract.

I give several of these reports merely that persons may see the manner in which they are made and the principles on which the practical recommendations are based.

Analysis of two samples of "Soil," marked No. 2 and No. 9, from near Petersville, Frederick Co., Md., for Thos. J. Marlow.

The samples of soil left at this office represent volcanic soils, viz: such as owe their origin and formation to volcanic rocks, upon which they directly lie. Mica slate is the rock of the products of degradation of which the above soils are chiefly composed; and the proportionately small quantity of the rock which, in the form of broken fragments, still remained undecomposed in the field, as well as the stiffness and most extensive depth of the soil, indicates that this process of degradation has here most perfectly and thoroughly taken place.

In regard to the mechanical texture of soils, it may generally be said that the bulk of soils consists on one side of quartz sand and the fragments of undecomposed rocks, and on the other of a compound consisting of certain portions of sand, clay, lime, magnesia and humus, forming a kind of "cement," which envelops and joins the quartz sand particles, and is itself again loosened by them. Of course, on the respective quantities of these two fundamental constituents of soil, its mechanical texture must depend, and consequently its water-retaining power, its consistency in the wet and dry state, its capacity to dry up more or less quickly, and its consequent contraction of volume, which gives rise to clefts and fissures tearing the roots; its capacity to absorb the atmospheric ingredients, to absorb heat and to retain heat, &c.

As to the proportion of "quartz sand and undecomposed rocks" to the "cement" in the above soils, it was found to be for No. 2, as 20 to 80, and for No. 9 as 25 to 75. Their degree of stiffness is, therefore, in ratio to the quantity of cement these proportions exhibit, viz: as 80 to 75, and if we term the soil No. 9 containing 75 per cent. of cement a clayey soil, the other, viz: No. 2, must be classed as a clayey soil of a higher degree of stiffness. A class of soils containing 50 per cent. of cement and up to 75 per cent. embraces the different kinds of stiff, loamy soils.

As to the character of the cement contained in the above samples of soil, it may be said that its proportion of sand, clay and humus is a good one and well adapted for this class of soils. In regard to its lime and magnesia, however, a more particular examination showed the quantity of the former to be deficient in a very extraordinary degree, whilst that of the latter, though predominant over the quantity of lime, was also somewhat deficient, and a *slight* increase, therefore, could also act beneficially on the mechanical texture of these soils. This state of things is in accordance with the particular origin of these soils as derived from the degradation of mica slate, a rock the component parts of which show exactly the above *relations*. As to the directly nourishing properties of the above soils, the analyses showed as follows·

Phosphoric acid, more than 120 lbs. per acre, (equal to about 11 bushels of bones. A sufficiency.

Sulphuric acid, less than 1 bushel of plaster of Paris contains. A deficiency.

Chlorine, more than 1 bushel of common salt contains, and less than 2 bushels for No. 2. A deficiency.

Potash, 0.32 per cent. An abundance in both soils.

The mechanical texture of the above soils will therefore be improved by the application of air-slacked lime, or still better by that of water-slacked lime, at the rate of 70-80 bushels for No. 2, and 60-70 bushels for No. 9. Water-slacked lime will soon become converted into air-slacked lime, and in this latter form will take part in the constitution of the cement, by which process the present natural stiffness of the cement will be diminished, and consequently the soil rendered more porous, dryer and warmer. Water-slacked lime, however, before being converted into air-slacked lime, exercises an important and beneficial influence on these kinds of soils, besides, which cannot be ascribed to slacked lime, at least not to the same extent, and for this reason the application of water-slacked lime will be preferable. This influence consists in the powerful solvent action of water-slacked lime on volcanic rocks, (silicates,) and also on clay, a product of the degradation of the former, by which means those constituents of soils change their composition in such a manner, that considerable quantities of silicate of potash are set free in it. In this soluble form silicate of potash is fit to be assimilated by plants, among the nutriments of which it takes the very first rank. Woodsboro limestone or any weak magnesian lime will best answer for these soils.

The directly nourishing properties of the above soils will be improved by the following applications, acoording to the result of analyses above given:

APPLICATION PER ACRE.

Plaster of Paris,	2 bushels for both soils.
Common Salt, (Refuse Salt,)	1 bushel for No. 2.
" " " "	1½ bushels for No. 9.

Which will bring up the respective deficiencies of sulphuric acid and chlorine in the above soils:

Peruvian Guano,	100 lbs. for both soils.

which will give to the crop a quick start and increase the action of the phosphates naturally contained in the above soils.

An application of any article, rich in phosphates, as Mexican guano, bone earth, bone black, &c., is quite unnecessary, and will be without the least effect, inasmuch as a natural supply of this substance is here furnished by the soil itself.

The result of the applications, recommended above, was of the most favorable kind, giving a very large return in the first crop over all other means. I regret, for the cause of agriculture, that the death of this noble, true-hearted, sincere, honest and intelligent gentleman has prevented me from giving a detailed statement of his particular experiments, the loss is great to the cause which he so ably defended and so successfully advanced, teaching both by precept and example. His death is no less a loss to the whole community than to the immediate circle of his relations and friends. May he rest in peace.

Several other specimens in different parts of this valley, show nearly the same composition; and so nearly the same are the great proportion of the soils of this valley, with the exceptions hereinafter named, not included on the mountain slopes, that directions for one will extend to all, and with the *same practical skill* in cultivation, nearly the same results will be attained. All the soils of this valley can be improved by lime. When I say *improved*, I mean that they will be made by it more permanently fertile, and will give better returns for the outlay than any other single application.

Some of the soils in this part of the valley are much lighter than others; these should especially be limed, as by this their texture will be much improved, and when convenient, the strongest and most adhesive clay should be spread over them. Much benefit may not be reailzed the first year, but the improvement will, though slow, be sure and continued. In the lightest of those soils coarse stable and barn-yard manure should be plowed under. Coarse manure should never be applied to the wheat crop on these light soils. At the foot of the South Mountain there are soils somewhat peculiar and differing from those last described. They have less of iron, being lighter in color than the generality of the soils of this section, and are compact, cold, heavy and wet. The first step in the improvement of these should be under drains. The mode in which these act in improving land, is by relieving it of its superabundant water, thereby making the soil more permeable to the air, and allowing the changes to go on it such as I have heretofore spoken of necessary to vegetation. On these soils, air-slacked lime is preferable to the water-slacked lime, as they already are very thoroughly decomposed, and require no more disintegration than can be effected by the decay of the vegetable matter (humus) in the soil. Air-slacked lime in this case makes the soil much more loamy, and improves its texture far more than water-slacked or quick lime.

The very reason that these latter soils should be treated with air-slacked lime is, as I have said, because their constituents have already become very much disintegrated. On the other soils this is not the case, they therefore, require such lime as will more powerfully decompose them; as this is water-slacked lime, it should be applied *always* to the land when it is first broken up by the plow, then harrowed in; by this means it becomes more thoroughly incorporated with the soil and performs the uses for which it was intended much more thoroughly than if not so mixed. As to the best mode of applying the various other manures necessary to these soils, I refer to the directions for their use under their appropriate heads and to my former reports on this subject.

The deficiencies as to nutrient substances will now be mentioned. First, phosphate of lime or bone-earth—this does not exist in *large* quantities in any of the soils of this valley, but still in quantities sufficient to produce good crops. Admitting even that these soils at one time contained the same quantity, yet it must be apparent that they could not at present contain it alike; those soils which have been freely cultivated and badly manured will have it in smaller proportions than those which have been more kindly treated. And even if they all have the same quantity of stable or barn-yard manure applied to them, yet the supply of phosphate of lime or bone-earth will vary in the same proportions as the manure is well or badly taken care of. In the way in which unfortunately this manure is preserved or rather not preserved, a large part of its phosphate of lime is lost by being carried off in the water which runs from the stable and barn-yards; this water is always highly charged with carbonic acid, produced by the decomposition of the vegetable matter in it, and when so charged, it readily dissolves phosphate of lime, and so our farmers lose by want of a little care and attention this necessary element, which they will at some future time have to replace at much cost and labor by the application of bone-dust, Columbian or Mexican guano.

In the soils described as approaching in their character to white oak soils, I have found a deficiency of phosphate of lime, except in those places where the soil is generally wet. This should be supplied by means of bone-dust, Columbian or Mexican guano. The soils in the middle part of the valley have it in more abundance. There may be, and doubtless are, many fields where this is deficient, but it is impossible to mention all of these particular locations. Any farmer before applying these manures, should have his soil examined for this constituent, and if the means be placed at my disposal, this shall in all instances be speedily done. It is certainly not prudent to be spending hundreds of dollars in the purchase of a manure containing a single valuable constituent, which, if already existing in the soil, will be so much money thrown away. This substance, phosphoric acid, can now be so accurately and speedily determined as to its quantity, that no one should hesitate in having it determined, though he should have to pay for this out of his own pocket.

The soils of all this valley are deficient in sulphuric acid and chlorine; the former is supplied most cheaply by plaster, the latter by common salt. If in any place plaster has refused to act, and disappointed the expectations of the farmer, it has been because there was some other defect in the soil, either mechanical or as to some necessary mineral constituent. For directions as to the quantity to be used, the time of application, the crops to which these should be used, I refer to the article on manures in the preceding part of this Report.

Mountain Slope Soils.—These embrace all of those soils lying on the eastern of the South, or the western slopes of the Catoctin Mountain. In these soils we have two very certain guides as to the knowledge of their composition, as to those elements which form the mass or body of the soil, and give to it its physical texture and mechanical constitution. They are not formed from the same rock as that from which the soils in the middle part of the valley were formed, but from one in which there was a large preponderance of epidote. I give here the average result of many specimens of this mineral in the rocks composing this soil from different localities; each one separately is not given because the extremes show the composition to be nearly the same, so far as practical recommendations to improve the texture of the soil is concerned. It is composed as follows, of:

Silica	51.00	per cent.
Alumina	25.90	"
Oxyds of Iron	12.40	"
Lime	9.10	"
Other substances not determined	1.60	"
	100.00	

As this exists in large quantities, we can now see from the above that the rocks which form these mountain slopes will, by their degradation, form a good soil as to texture when properly cultivated. But there is this very important difference in them from the soils in the middle of the valley, though they look very much alike, and are somewhat similar in texture. The soils of the valley, formed by decomposition of mica slate and shales, require some agent to effect their decomposition. They have enough of lime, and nearly enough of magnesia, but not in an isolated form. The addition, then, of a weak magnesian lime to these soils is all that they require to set free both lime and magnesia in sufficient abundance. On these mountain soils the case is different, they have a large abundance of lime, and only a trace of magnesia. They, too, require degradation, they need that their insoluble compounds shall be rendered soluble. Pure lime would effect this, but pure lime cannot supply magnesia. Limestone containing a large quantity of magnesia then should be applied to these soils, it will rapidly disintegrate them, and at the same time supply a useful and necessary constituent of the soil. Here then is a great practical difference in the composition of these soils, and they must be treated accordingly. A weak magnesian lime will most benefit the valley soils, and least the mountain slope soils; the strongest magnesian lime will most benefit the mountain slope soils, and least those in the middle of the valley. For the sources of those two varieties of lime stone, I refer to the analyses of limestones in a succeeding part of my report.

There is another characteristic of this variety of soil, which is the large quantity of phosphoric acid which it contains; therefore, there should not be applied either bone dust, Columbian or Mexican guano to it. It has a deficiency of common salt and plaster of Paris, these two should be applied according to directions given under the head of manures.

This description fairly represents all this class of soils, and the directions here given may be followed with profit by all those who may have them in cultivation.

Red Lands.—By this name is known and recognized a peculiar variety of soils in Frederick county, extending from the southern borders of Adams county, in Pennsylvania, to the bottom lands of the Potomac. They lie nearly parallel to the Catoctin Mountain, and in the upper part of the county lie between the mountain slope soils and the blue slate soil, lower down the clay lime-stone soils are interposed between them and the blue slates. The surface of these soils is gently undulating or nearly level; their color is a reddish chocolate color, in some places inclining to a bluish slaty color. The surface soil in many places is shallow, being underlaid by hard compact shales, which, on exposure to the air, become broken into small fragments, which will gradually disintegrate and then be converted into soil.

These compact shales underlying the soil at various depths materially influence, the crops grown on it. When they lie near the surface, the crops suffer severely from droughts. When there are heavy rains the surface soil is liable to be washed off, leaving the bare abraded surface of the rocks. Where the soil is deeper it is mostly in basins or large flats, whence it has been washed from the surrounding hills, and has too large a quantity of water in the subsoil, which is continually rising to the surface, and by its evaporation producing a degree of coldness unfavorable to the quick germination of seed, or the vigorous growth of crops. Wheat on this kind of land is exceedingly liable to "freeze out" and be winter killed.

This variety of land, when properly improved and cultivated, is very productive, and being now cheap, offers most profitable chances for investment. No lands in the county will give a more ready return for outlay, either of labor or capital, on them, than these red lands of Frederick and Carroll counties.

These red lands are much modified next to the mountain by washings from it, and gradually intermix with the slate and lime-stone lands, which form their eastern border. In the neighborhood of Frederick city for several miles above the turnpike to Hagerstown, they are so blended with the clay limestone as almost to lose their distinctive character, which they again assume, before the Jefferson road crosses them, they then maintain their peculiar appearance until they mingle with the Potomac bottoms.

The composition of these soils, and the means for their improvement, will be best shown by the following analysis and reports, made from soils in the upper part of Frederick county, the farm of Samuel Motter. I give these reports and analysis because they truly represent each variety of this class of soil.

The samples of soil sent to this office were marked No. 2, No. 3, No. 6, (A,) No. 6, (B,) and No. 9. The examination of their constituents proved that they were of the same origin viz: the products of the degradation of the gray and red varieties of clay slate, and that they differ only in regard to the proportion of sand and fragments of undecomposed rocks to the "cement" they contain.

As to the proportion of quartz-sand and rocks to the "cement" in the above soils, it was found to be for No. 2, 38-62; for No. 3, 42-58; for No. 6, (A,) 47-53; for No. 6, (B,) 50-50; and for No. 9, 35-65. Provided that the character of the 'cement' is the same for all these soils, the degree of stiffness is then in ratio to the quantity of 'cement' these proportions exhibit, viz: 50, 53, 58, 62, 65; and if we term the soil containing 50 per cent. of 'cement' a loamy soil, the others must be classed as loams in different degrees of clayeyness; a class of soils which generally exceeds all others in productiveness and which is capable of assuming the highest state of fertility, by comparatively the smallest means for renovation. A class of soils containing 75 per cent. of 'cement' or more, embraces the different kinds of stiff clay soils.

As to the character of the 'cement' contained in the above samples of soil, it may in general be said that the proportion of sand, clay and humus is the same in all of them, and well adapted for this class of soils. In regard to the quantities of lime and magnesia present in the cement, a more particular examination showed as follows: No. 9, containing the largest quantity of 'cement,' had proportionally an abundance (sufficiency) of lime but small quantities of magnesia; No. 2, containing the next largest quantity of cement, had but small and deficient quantities of both lime and magnesia; No. 3, containing an average quantity of cement, had a proportionally small and deficient quantity of lime, but magnesia in too great abundance; No. 6, (A,) containing a smaller quantity of cement than the former, had an abundance of lime, and of magnesia a quantity not able to counterbalance the abundance of the former; No. 6, (B,) containing the smallest quantity of cement, had a good corresponding quantity of both lime and magnesia, the latter being rather predominant.

As to the directly nourishing capacity of the above soils, the analysis showed as follows:

Phosphoric Acid is, less than 1 bushel of fresh bones contains, in No. 2
more than 3 bushels " " " in No. 3
less than 1 bushel " " " in No. 6, (A)
do in No. 6, (B)
do in No. 9

Sulphuric Acid is, less than one bush. Plaster Paris contains in No. 2
do in No. 3
less than 2 bushels in No. 6, (A)
less than 1 bushel in No. 9
Chlorine is, more than 2 bushels of common salt contain, in No. 2
less than 1 bushel in No. 3
do in No. 6 (A)
less than 2 bushels in No. 6, (A)
Potash, from 0.07 to 0.14 per cent.

Improvement of the mechanical texture of the soil.

Considering the respective quantities of lime and magnesia in No. 6, (A,) and No. 6, (B,) of which the former contains a predominant quantity of lime against magnesia, the latter on the contrary a predominant quantity of magnesia over lime, and judging from the fact that the yield in grain and grass has been considerably less on the part represented by No. 6, (A,) than that by No. 6, (B;) and considering farther the similar qualities of both soils in all other respects, both being parts of one and the same field, we must come to the conclusion that the proportion of lime and magnesia best adapted for these particular kinds of soil is such that magnesia, if not exceeding the lime in quantity, should at least, be equal to it.

In accordance with this conclusion, the following applications may be recommended for the improvement of the mechanical texture of the soils, with reference to the analyses of limestones hereafter given:

Applications per acre in the Fall.

No. 2	20 bushels of No. 4, (Young's.)
No. 3	10 bushels of No. 3 (Woodsboro'.)
No. 6, (A)	10 bushels of No. 4, (Young's.)
No. 6, (B)	
No. 9	10 bushels of No. 4, (Young's)

The directly nourishing properties of these soils will be improved by the following applications, according to the result of analyses above given:

Application per Acre.

	No. 2	No. 3.	No. 6, (A)	No. 6, (B)	No. 9.
Mexican Guano	300 lbs.	——	300 lbs.	300 lbs.	300 lbs.
Plaster of Paris	2 bush.	2 bush.	1 bush.	2 bush.	1 bush.
Common Salt	——	1½ bush.	1½ bush.	1 bush.	1 bush.

These three applications will supply the respective deficiencies of phosphoric acid, sulphuric acid and chlorine.

Peruvian Guano	80 lbs.	80 lbs.	80 lbs.	80 lbs.	80 lbs.

which will give to the crop a quick start and increase the action of the Mexican Guano.

These applications were eminently successful.

Specimens of this soil were examined between Emmittsburg and Creagerstown; on the farm of Michael Zimmerman; on the Jefferson turnpike; where the red lands are crossed by the Baltimore and Ohio rail road; a few miles below this point, and on many intermediate points. The conclusions to which these examinations have led me, are these: 1st. That these lands require air-slacked lime—this must be either pure or magnesian, according to the following circumstances. On the hills, and where the soil has been subject to much washing, where the rocks or underlying shales come near to the surface, magnesian lime should be used. On the levels and bottoms, a pure lime will best supply the defects of the soil. It would seem that in this there is a contradiction to what I have previously stated, viz: that these bottoms and level lands were formed by the washings from the hills, and the question will at once arise, why should the bottoms differ in their chemical composition from the hills from which they are formed? The cause is this, water falling on the hills and running down their sides, carries with it all the pure disintegrated particles of soil, and will dissolve most of those matters which are most soluble in it; now the original composition of the soil being the same in the hills, when it reaches the bottom it will relatively contain the most of that which is most insoluble. Magnesia being much more insoluble than lime, it will exist in comparatively greater abundance in the valleys, bottoms and plains, which are the washings of the hills, than lime; hence, though magnesian lime be the best application on the hills and high grounds, yet in the bottoms and plains a pure lime will be found most advantageous.

For a table of the different varieties of limestones, see limestones from Frederick county.

As the varieties of this soil differ, so must their manuring with stable manure and green crops, according to the principles laid down under the head of manures, and which it is unnecessary here to repeat. These soils are uniformly deficient in plaster and salt; these should be applied to the crops in the mode pointed out in the section treating of these articles. Whenever these lands are too wet, and in many places this is the case, they should be thoroughly ditched and drained; without this, no return need be expected from labor, nor remuneration for expenses in manures. Where the rocks and shales lie near to the surface, the first thing to be done is to prevent the loss of soil by the effect of the washing of heavy rains, and to prevent this, I know of no better plan than surface drains, made with a plow, and subsequently cleaned out with the hoe, sufficiently near to each other to carry off all the surplus water of the soil; the water by these means being distributed in many channels, could no where collect in sufficient abundance to carry off the soil and make unsightly gullies. These drains should have but a slight fall, and end by conveying the water to a fence, woodland or some stream.

In these locations soils should be plowed deeply, as the deeper the soil the more room would the surplus water have to diffuse itself, and prevent injurious washing.

The benefits resulting from the above recommendations will be two fold, first, the direct saving of a large quantity of land, for when the whole mass of the soil is washed off, some years must elapse before the hard shaly subsoil becomes sufficiently disintegrated and decomposed to furnish a good foundation for crops; secondly, the retention of the finely divided particles of soil, that part which contributes directly to the nourishment of the plant, from being washed out by a large mass of water rapidly passing through it. Indeed, on all of this variety of soils we must recommend deep plowing, and on the stiff heavy parts of it, the turning in of green clover crops. *With regard to the nutrient manures necessary to meet its deficiencies, I can best advise that phosphate of lime, whether in the form of Columbian guano, Mexican guano or bone dust, be but sparingly applied, and that only on soils that have been a long time in cultivation and not well manured.* Where these soils are deep and have been well improved, the use of stable manure preserved as I have directed, with the addition of one hundred pounds of good Peruvian guano to the wheat crop, will supply an abundance of phosphoric acid to soils that have been well improved, with a deep soil, that is, one where the rocks or shales do not come near to the surface, for a full rotation. On these latter soils phosphoric acid in some form is necessary, because they do not contain it in sufficient abundance to meet the wants of a large crop. This defect can be readily explained. The phosphate of lime, whose valuable constituent is phosphoric acid, is liable to continual depreciation in soils from two causes: first, removal by crops; secondly, its removal by the rain water, which dissolves and carries it off; its supply is afforded by two ways, first, its direct supply by means of manures containing this substance, and secondly, its deposition in the soil in being brought up from the subsoil during droughts in the manner which I have explained on page 56 of this Report. On soils which have but little depth, and whose subsoil is impermeable to water, no supply of phosphoric acid or any other mineral substance can be received by the agency of the latter cause; they are therefore liable to continual loss of this substance by reason of the two foregoing causes of loss, and are deprived of any supply by drought; they, therefore, other things being equal, will soonest become deprived of their soluble saline ingredients, and soonest of those which exist in the least quantity—therefore only on shallow soils and hill sides should substances containing phosphate of lime be applied.

On these soils sulphuric acid and chlorine are deficient, and are to be supplied by plaster of Paris and common salt, according to directions before given.

The above practical recommendations are based on the result of many analyses and examinations of this variety of soil, and the results of the most successful cultivators resident on it.

The soils at the foot of the Catoctin Mountain vary as the washings from it are more or less mingled with the red soil. Several analyses were made of these from the farm of the Hon. F. A. Schley, and when the results of the applications recommended are determined they will be published in the county papers, and cannot fail to be of great interest to all having land in that location.

Clay Limestone Land.—This is a distinct variety of soil, characterized by a gentle undulating surface, heavy compact clayey subsoil, loamy surface soil due to a large proportion of vegetable matter; the color of these soils is a deep yellow.—This soil has extensive limestone ridges running through it parallel to the mountain ranges, and lies adjacent to the red lands just described, on the west, and the blue or roofing slates on the east; it is most found on the west bank of the Monocacy and extends from what is known as "the glades" to the Potomac river, with the exception of a narrow belt of river bottom.

This soil is naturally very productive, but has been somewhat reduced from its original fertility by hard cultivation and by being manured almost solely by a special manure—plaster of Paris. This portion of the county is universally so well cultivated that I shall not attempt to give directions on this head; the farmers plow deeply and follow very judicious rotations. The results of many analyses of this variety of soil establish the fact that water-slacked lime, should be applied to it when a heavy compact unreduced clay is brought to the surface; and when loamy, air-slacked lime. The best variety of lime for these soils is a pure lime such as can be found in many places in it:

the only exception to this, is where loose light porous soils occur, which are of but small extent; here magnesian lime is the proper variety.

As to the nutrient substances, phosphate of lime, either in the form of bone dust, Columbian or Mexican guano, should be applied, as the quantity in any of these soils is not sufficient for the *practical* wants of such a series of crops as the texture of the soil could produce if aided by this manure. Wherever the wheat is liable to fall, and of this farmers themselves are the best judges, there common salt should be sown as before directed. Plaster should be applied to the clover crop and to none other.

Slate Soils.—We now come to another, a different, and a distinct formation, namely, the slate soils in the eastern section of the county. These soils differ very much in their productiveness; this is not so much owing to their constituents as to the *condition in which they exist, the extent to which the underlying slates have become disintegrated, and the depths of soil.* Where the slates lie very near the surface, where they form in their undecomposed state a large proportion of the soil, the land is barren and unproductive—where the soil is deep, this depth arising either from deep plowing or from alluvial deposits, it is *always* productive; this teaches us a lesson how to improve the soils which are barren. Make them as deep as possible by cultivation, and decompose the coarse fragments of slate as much as possible by agents which can do this, which are lime and green crops turned under and intermixed with the soil.

The rocks from which all these soils are composed, with the exception to be mentioned in this eastern section of the county, are either blue slate, red slate, talc slate or chlorite slate. The composition of these slates is but slightly different, the brighter color of the yellow and red slates being owing to the presence of iron in a higher degree of oxydation than in the black or blue slates; moreover, all of these are so much intermixed and so closely allied to each other, that it would be useless to go into their separate composition, to determine the composition of the soil which they formed, and to show the means of its improvement. Fortunately this is not a matter of much practical importance, and we shall speak of the slate lands under one head, and make such practical deductions from their composition and from *all other* facts connected with them, as may best lead to a rational system for their improvement. We find in that section of the county of which I am now speaking, an admixture of all these slates. I do not profess to describe the various soils which result from these various combinations, and it would be useless were I able to do so, since the productiveness of soils depends on their mechanical texture and nutrient ingredients ; practical advice must only consider these two conditions, and when it can show what will improve the one, or supply the defects of the other, then has it done all that is necessary for the improvement of the soil.

The main body of the soils in this section of the county, may be divided into two classes ; first, those which are shallow and closely underlaid by the rocks and slates, and secondly, those which are deep, having the slates some distance below the surface. The former are always barren and unproductive, the latter generally rich and producing large crops. As the rocks from which these soils are derived are *practically* the same in composition, we must look to their mechanical texture for an explanation of their different degrees of fertility. In the former we have the same mineral substances, but not in a condition to be absorbed by the plant. The soil as formed has been washed off, and that which remains is not deep enough to meet the wants of plants in retaining a sufficiency of moisture for their support; from the large per centage of *undecomposed* rocks in the soil, a sufficiency of mineral matters is not set free to meet the wants of a large crop. The indications then to be carried out are, first, to deepen the soil ; second, to decompose the undecomposed rocks which are in it. The first of these indications is to be fulfilled by deep plowing and the most thorough cultivation ; the second by the application of *lime*, and lime of the purest kind. No magnesian lime should be used on these soils, as the slates from which they are formed contain it in the greatest abundance, and by its being liberated will, with lime, form a very compact soil, endowed with all the mechanical advantages which belong to the best soils.

These shallow barren soils adjacent to the Baltimore and Ohio Railroad, those near to the Montgomery line, those in that part of the county next to the Carroll border, and indeed in whatever part of this section of the county they may exist, can be made by these means, viz : deep plowing, the application of pure lime, the turning in of green crops, as productive as the valley of Linganore, the bottom lands of Pipe or Sam's creek, or the lands in Middletown valley, so far as that fertility depends on their mechanical texture. .This I now say, and this result many who may read these pages will live to witness. Nothing is wanting but the means which I have suggested, and the same practical skill as is exhibited in the different localities that I have named.

The deep soils, such as are found in various parts of this section of the county, particularly in Linganore valley, on Sam's creek and other places were they exist, require small additions of pure lime, except where they have had clover leys turned under, and been well manured with stable or barn-yard manure. These two applications on the deep soils will sufficiently disintegrate the soil, perfect its mechanical texture, and afford abundant nutriment for crops. On these soils, where there has been a long and exhausting system of cultivation and but little application of stable manure, some subtance, such as bone-dust, Mexican or Columbian guano, should be used. The soils here, which are shallow, poor, and composed of a large per centage of coarse fragments of rocks, need none of the above substances, as they uniformly contain a large, sometimes a very large proportion of phosphoric acid, and therefore need not the application of substances whose value depends on this constituent.

I have said that all of these soils, with the exceptions to be hereinafter named, contain magnesian compounds in sufficient abundance. The exceptions are, a narrow ridge of land called Sandy Ridge, which is characterized by the presence of large masses of sandstone rocks, and by a loose, "gritty" sandy soil. Here magnesian lime must be employed, as those soils are very deficient in it, and also on other belts of land in this section of the county which are characterized by the presence of a hard sandstone, of a yellowish, olive, or greenish color; these soils are similar to those on the slopes of the Catoctin Mountain, and should be manured with magnesian lime. Plaster and salt should be used on all of these soils in the quantity and mode pointed out when I spoke of these articles.

I have not given the various analyses nor a statement of the various facts on which the above recommendations rest. They, however, are founded on a large number of analyses, and results deduced from all the facts which could be gathered either from practical men or from my own observation. They can be depended on, and should any one require any explanation of what I have said, or fuller instruction as to these soils, limestones or manures, than that which I have above given, he can command my services by addressing me.

I now come to the limestones of Frederick county, of which it contains a sufficient abundance and sufficient variety to meet all the wants of this and the adjacent counties. The analyses given have been all sent to their respective owners, but for the sake of general information, I here publish them. There are many various soils in this county, as to their respective quantities of lime and magnesia, many various limestones containing nearly one-half of magnesia, and many contain none at all. Many thousands of bushels of limestone are burnt and sold to the farmers of this county, and it is vastly important for them to know which soils are magnesian and which not, which limestones are magnesian and which not, that the latter may be properly adapted to the former. Common sense will show the propriety of the above suggestions, and common practice will vindicate the utility of the recommendations which I have given as to the manuring and cultivation of the soils of Frederick county.

LIMESTONES *from Frederick county.*

1. Limestone from Clairvaux, near Mt. St. Mary's College.

A dark bluish gray variety of a rough texture, and traversed by numerous small veins of white calc spar.

Upon analysis it was found to be composed as follows:

Carbonate of lime	77.4
Carbonate of magnesia	20.5
Sand and clay	2.1
	100.

When burnt, 100 parts will therefore yield of—

Caustic lime, (quick or burnt)	43.3
Caustic magnesia	9.3

and when water-slacked, of—

Water-slacked lime	57.3
Water-slacked magnesia	13.5

2. Limestone from Young's, near Mechanicstown, and N. E. thereof.

A light breccia.

It was found to be composed as follows:

Carbonate of lime	59.0
Carbonate of magnesia	40.0
Sand and clay	1.0
	100.

When burnt, 100 parts will therefore yield of—

Caustic lime	33.0
Caustic magnesia	18.2

and when water-slacked, of—

Water-slacked lime	43.6
Water-slacked magnesia	26.4

3. Limestone from Adams county, Pa., (Marshal's,) 8 miles from Emmittsburg, used considerably in Frederick county.

It represents a hard, light gray mass of uniform texture.

Its composition is as follows:

Carbonate of lime	97.5
Carbonate of magnesia	1.5
Sand and clay	1.0
	100.

When burnt, 100 parts will therefore yield of—

Caustic lime	54.6
Caustic magnesia	0.7

and when water-slacked, of—

Water-slacked lime	72.1
Water-slacked magnesia	1.0

4. Limestone from Adams county, Pa., (Wurtz's,) 4 miles from Emmittsburg, and also extensively used in Frederick county.

A dark, rough breccia.

Upon analysis it was found to be composed as follows:

Carbonate of lime	55.5
Carbonate of magnesia	25.0
Sand and clay	19.5
	100.

When burnt, 100 parts will therefore yield, of—

Caustic lime	31.1
Caustic magnesia	11.4

and when water-slacked, of—

Water-slacked lime	41.1
Water-slacked magnesia	16.5

5. Limestone from Woodsborough, for Samuel Motter.

Of a very fine grain and uniform texture.

Composed as follows:

Carbonate of lime	92.3
Carbonate of magnesia	6.0
Sand and clay	1.7
	100.

When burnt, 100 parts will therefore yield of—

Caustic lime	51.7
Caustic magnesia	2.7

and when water-slacked, of—

Water-slacked lime	68.3
Water-slacked magnesia	4.0

6. Limestone from Woodsborough, for Samuel Phipps.

Dark gray amorphous mass, intermixed with white calc spar.

The following is its composition:

Carbonate of lime	94.5
Carbonate of magnesia	5.2
Sand and clay	0.3
	100.

When burnt, 100 parts will therefore yield of—

Caustic lime	53.0
Caustic magnesia	2.5

and when water-slacked, of—

Water-slacked lime	70.0
Water-slacked magnesia	3.6

7. Limestone from Woodsborough, for John Smith.

Light gray amorphous and uniform mass.

It was found to be composed as follows:

Carbonate of lime	98.4
Carbonate of magnesia	0.7
Sand and clay	0.9
	100.

When burnt, 100 parts will therefore yield of—

Caustic lime	55.2
Caustic magnesia	0.3

and when water-slacked, of—

Water-slacked lime	72.8
Water-slacked magnesia	0.4

8. Limestones from Frederick District, for Mr. Brengle, marked No. 1 and No. 2:

No. 1, light gray and homogeneous mass, with white crystals of calc spar.

No. 2, dark gray variety, with crystals of calc spar and quartz intermixed.

Upon analysis they were found to be composed as follows:

	No. 1.	No. 2.
Carbonate of lime	94.6	86.0
Carbonate of magnesia	5.2	6.8
Sand and clay	0.2	7.2
	100.	100.

When burnt, 100 parts resp. will therefore yield of—

Caustic lime	53.0	48.0
Caustic magnesia	2.5	3.0

and when water-slacked, of—

Water-slacked lime	70.0	63.6
Water-slacked magnesia	3.6	4.5

9. Limestone from near Springfield, Creagerstown District, for Hon. F. A. Schley:

Dark gray mass, with white veins of calc spar traversing.

Its composition is as follows:

Carbonate of lime	55.9
Carbonate of magnesia	42.6
Sand and clay	1.5
	100.

When burnt, 100 parts will therefore yield of—

Caustic lime	31.4
Caustic magnesia	20.5

and when water-slacked, of:

Water-slacked lime	41.4
Water-slacked magnesia	29.5

10. Limestone from near Springfield, for P. Fitzhugh:

Light gray variety, with white and red veins of calc spar traversing.

It is composed as follows:

Carbonate of lime	63.1
Carbonate of magnesia	35.7
Sand and clay	1.2
	100.

When burnt, 100 parts will therefore yield of—

Caustic lime	35.4
Caustic magnesia	17.2

and when water-slacked, of—

Water-slacked lime	46.7
Water-slacked magnesia	24.8

11. Limestone from near Springfield, for F. Kronise.

Light gray limestone of crystalline texture, covered with a reddish coating.

Its composition is the following:

Carbonate of lime	69.1
Carbonate of magnesia	30.1
Sand and clay	0.8
	100.

When burnt, 100 parts will therefore yield of—

Caustic lime	38.7
Caustic magnesia	14.5

and when water-slacked, of—

Water-slacked lime	51.1
Water-slacked magnesia	20.9

12. Limestone from ⋈ roads, east of Unionville, Liberty District, for Elhanan Urner.

Of white color and crystalline texture.

The following is its composition:

Carbonate of lime	98.3
Carbonate of magnesia	1.1
Sand and clay	0.6
	100.

When burnt, 100 parts will therefore yield of—

Caustic lime	55.1
Caustic magnesia	0.5

and when water-slacked, of—

Water-slacked lime	72.7
Water-slacked magnesia	0.7

13. Limestone from near Unionville, for N. H. Owings.

Dark bluish gray variety of a slatish texture.

Its composition is as follows:

Carbonate of lime	99.5
Carbonate of magnesia	0.5
Carbon	trace
	100.

When burnt, 100 parts will therefore yield of—

Caustic lime	55.8
Caustic magnesia	0.2

and when water-slacked, of—

Water-slacked lime	73.7
Water-slacked magnesia	0.3

14. Limestones from head of Dollyhide, Liberty District, marked No. 1 and No. 2, for Jacob Houck.

No. 1, of flesh color and crystalline texture.

No. 2, of reddish white color with crystals of calc spar imbedded.

Upon analysis they were found to be composed as follows:

	No. 1	No. 2
Carbonate of lime	97.5	95.3
Carbonate of magnesia	1.3	2.5
Sand and clay	1.2	2.2
	100.	100.

When burnt, 100 parts will yield of—

Caustic lime	54.7	53.4
Caustic magnesia	0.6	1.1

and when water-slacked, of—

Water-slacked lime	72.2	70.5
Water-slacked magnesia	0.9	1.7

15. Limestone from near Unionville, for O. P. Harding.

White uniform mass of crystalline texture.

Its composition is as follows:

Carbonate of lime	92.0
Carbonate of magnesia	7.5
Sand and clay	0.5
	100.

When burnt, 100 parts will therefore yield of—

Caustic lime	51.5
Caustic magnesia	3.6

and when water-slacked, of—

Water-slacked lime	68.5
Water-slacked magnesia	5.1

16. Limestone from near Liberty, for Dr. Thomas Sim.

Hard, crystalline mass, intermixed with chlorite slate and veins of calc spar.

An average sample of two specimens was found to be composed as follows:

Carbonate of lime	50.0
Carbonate of magnesia	30.5
Chlorite slate	19.5
	100.

When burnt, 100 parts will therefore yield of—

Caustic lime	28.0
Caustic magnesia	14.7

and when water-slacked, of—

Water-slacked lime	37.0
Water-slacked magnesia	21.2

17. Limestones from Liberty District, marked No. 1 and No. 2, for Thomas G. Maynard.

No. 1, dark gray mass of crystalline texture, and white calc spar imbedded.

No. 2, a white crystalline variety of fine grain.

Upon analysis they were found to be composed as follows:

	No. 1	No. 2
Carbonate of lime	96.0	99.9
Carbonate of magnesia	2.5	0.1
Sand and clay	1.5	——
	100.	100.

When burnt, 100 parts respectively will therefore yield of—

Caustic lime	53.7	56.0
Caustic magnesia	1.1	——

and when water-slacked, of—

Water-slacked lime	71.0	74.0
Water-slacked magnesia	1.7	——

18. Limestones from Liberty District, marked No. 1 and No. 2, for Adam Nusbaum.

No. 1, hard and compact mass of dark steel gray color and fine grain.

No. 2, light gray mass with white veins of calc spar interchanging.

Their composition is as follows:

Carbonate of lime	98.5	96.2
Carbonate of magnesia	0.3	2.5
Sand and clay	1.2	1.3
	100.	100.

When burnt, 100 parts resp. will therefore yield of—

Caustic lime	55.2	53.8
Caustic magnesia	0.1	1.1

and when water-slacked, of:

Water-slacked lime	72.9	71.2
Water-slacked magnesia	0.2	1.7

19. Limestones from Liberty District, marked No. 1, No. 2, "the rock from which we have been burning," and No. 3, "Jeremiah Fox's," for Mrs. Burgess.

No. 1, a dark-red breccia with veins of white calc spar.

No. 2, hard and compact mass of very fine grain; dark colored, interchanging with strata of chlorite slate.

No. 3, breccia of light red colors and nests of white calc spar imbedded.

Upon analysis, they were found to be composed as follows:

	No. 1.	No. 2.	No. 3.
Carbonate of lime	56.4	47.7	54.8
Carbonate of magnesia	38.0	29.1	44.0
Sand and clay (chlorite slate in No. 2)	5.6	23.2	1.2
	100.	100.	100.

When burnt, 100 parts resp. will therefore yield of—

Caustic lime	31.6	26.7	30.7
Caustic magnesia	18.3	14.1	21.3

and when water-slacked, of—

Water-slacked lime	41.7	35.3	40.5
Water-slacked magnesia	26.2	20.2	30.5

20. Limestone from Liberty District, for Stoner & Hilhide:

Compact mass of fine grain and light colors.

Its composition is as follows:

Carbonate of Lime	99.3
Carbonate of magnesia	0.5
Sand and clay	0.2
	100.

When burnt, 100 parts will therefore yield of—

Caustic lime	55.6
Caustic magnesia	0.2

and when water-slacked, of—

Water-slacked lime	73.5
Water-slacked magnesia	0.3

21. Limestone from Point of Rocks, Petersville District, from the Southern part of Middletown Valley, near Potomac River, for George P. Remsberg:

Light gray mass of uniform crystalline texture.

Its composition is as follows:

Carbonate of lime	65.1
Carbonate of magnesia	34.3
Sand and clay	0.6
	100.

When burnt, 100 parts will therefore yield of—

Caustic lime	36.5
Caustic magnesia	16.5

and when water-slacked, of—

Water-slacked lime	48.2
Water-slacked magnesia	23.8

22. Limestones from Liberty District marked Nos. 1, 2 and 3, for F. Garber.

No. 1, of fine crystalline texture and dull shades of color.

No. 2 is of white color, vitreous lustre, and exhibits a perfect rhombohedron.

No. 3 is a hard and compact mass of dark red color in which nests of white calc spar are imbedded. It is associated with strata of chlorite slate.

Upon analysis they were found to be composed as follows:

	No. 1.	No. 2.	No. 3.
Carbonate of lime	57.0	100.	77.7
Carbonate of magnesia	42.5	—	19.8
Sand and clay	0.5	—	2.5

When burnt, 100 parts respectively will therefore yield of—

Caustic lime	32.	56.	43.5
Caustic magnesia	20.4	—	9.6

and when water-slacked, of—

Water-slacked lime........................	42.2	74.2	56.5
Water-slacked magnesia................	29.4	00.0	13.8

The limestones which are composed partially of chlorite slate, such as those sent by Dr. Sim, (No. 16,) and Mrs. Burgess, (No. 19,) will act very speedily when burnt, in consequence of double silicates of lime or magnesia and alumina being formed in them. These silicates act by absorbing and retaining the ammonia of the atmosphere, as has been fully explained before, and the action of this lime is to a great extent similar to Peruvian guano on the first crop, and will be very permanent.

The above views, given before I had been aware of the practical effects of this variety of lime, have been fully sustained by the testimony of those who have used it.

This county is well watered by means of the Monocacy river, Catoctin creek and their various tributary branches, on which are many large merchant mills for the manufacture of flour. There are also several manufacturing establishments in the county, where agricultural implements are made with as much practical skill, and generally out of better material than those obtained from our large cities. Much attention is being paid to improved breeds of stock, and the annual exhibitions of the Frederick County Agricultural Society, in every thing that *properly* belongs to agriculture, will not suffer in comparison with any exhibition in the State.

CALVERT COUNTY.

The examinations of this county have neither been as full as I desired to make, nor as thorough as the wants of the community required. Its soils have been examined as far as was possible, under the circumstances in which I was placed, and what I shall say of them will instruct as to their economical improvement. There are many special varieties which have not been investigated as to their properties, and of these I shall not speak. Those which I may mention will be fully described, so that they may be recognized, and the advice given in relation to them will insure to their owners large returns for all their trouble and expense, should they carry it out in practice. I deem it best, and so have acted, to say nothing on subjects unless with a complete knowledge of them. It is preferable, though perhaps not politic, to be silent as to the composition and qualities of soil which have not been determined by analysis, and whose history as to previous manures and cultivation have not been furnished by their owners.

From this county *every specimen* of soil sent to me has been fully examined. I have passed through it in almost every part; requested orally and desired by letters that specimens of every variety of soil should be forwarded to me, and have taken some myself. I could not, however, with the only mode of conveyance at my disposal, bring away many specimens, and must not be condemned for not doing that which was impossible to be done without co-operation on the part of the planters and farmers of the county. There are yet lectures to be delivered in this county, and when the means are placed at my disposal to properly examine all the variety of soils, then will I give such instructions as will conduce not only to immediate returns in crops for any money expended in manures, but also to the permanent fertility of *all* the soils. It is physically impossible for any one traveling on horseback to convey specimens of soils; it cannot reasonably be expected. Those who have sent specimens taken according to my published directions, which have not been examined and reported on, have a right to complain, and none others. I desire particular attention to the instructions which I shall give, and those who may carry them out will find large profits accruing to them.

Calvert county is the extreme of the peninsula formed by the Patuxent River on the west, and the Chesapeake Bay on the east, it joins Anne Arundel county on the north, and ends in a point where the Patuxent River empties into the Chesapeake.

The face of the county is generally hilly, and traversed by deep ravines made by the water courses which empty into the bay and river, this is more particularly the case on the bay shore, and in the middle and central parts of the county. The soil is entirely alluvial in every part, in some places naturally very fertile, and nearly every where capable of a high degree of improvement, by attentive cultivation and proper manuring; it is generally light, with no impervious strata lying near the surface, is easily cultivated and responds very readily to proper improvement. It has received but little aid from manures, and in many instances its cultivation has been much neglected, yet some of the best lands, some of the best farms and plantations, and some of the most intelligent practical farmers and planters in the state may be found in Calvert county. Its natural advantages of location as to a cheap conveyance to market, and its natural resources for improvement are very great, and the waters which nearly encompass it, furnish all the means and appliances for the luxuries of good living. The county is already healthy, and can be made much more so by proper attention paid to draining and the cultivation of its soils. Its inhabitants have ever been famous for their unbounded hospitality.

The land in this county is very cheap, and I have known sales made of farms here at a rate one-fourth of that which even inferior land has brought in other parts of the state, with inferior advantages as to transportation and convenience to market. To men with small capital, but few places offer better inducements for investing it, and but few places any where can be found where strangers would meet with a more cordial welcome, or sooner find themselves "at home." The soils of this county shall only be described as far as their varieties have been examined. We have in the upper part of this county, in the neighborhood of Smithsville, those rich alluvial soils which I described in a former report, under the name of "West River Soils," which are found with some slight modifications, (depending on culture and the rotation of crops,) in various parts of the county, extending from the Anne Arundel border on the bay shore far down the county, and also on the Patuxent border. This soil even in its poorest condition can be improved to a very great extent solely by the addition of plaster and clover. It has fine texture, and belongs to the class of sandy loams, as their coarse quartz sand and gravel in almost every case exceed fifty per cent. There are hundreds of instances where these lands have been increased ten fold in productiveness by the sole application of one or two bushels of plaster per acre.

The examination of all the varieties of this soil shows the presence of a large quantity of phosphoric acid in it, with abundance of potash and soda. Their texture can be improved by the addition of small quantities of magnesian lime, which should be applied on the surface, and then suffered to lie there some time before being turned under ; it would materially improve their cohesion and make them much better adapted for wheat. On these loamy soils neither bone dust, Mexican or Columbian guano would act well. The application of one hundred pounds of good Peruvian guano will supply to the wheat crop an abundance of the phosphate lime with that naturally existing in the soil, and be sufficient for the crops succeeding it. I scarcely deem it necessary to advise the use of plaster, as that is already used by every one. Whenever marl, especially that which is mixed with clay can be procured, it should be applied to these soils. There is no application which, while it may increase a present crop, will so materially conduce to the permanent improvement as the clayey shell marl. Though they may be fertile, yet they are not what they can be made by the application of this substance or by the application of magnesian lime. I have said that these soils extend on the Patuxent and Chesapeake, far down the county. Now between these is another very distinct soil, differing in its fertility, being very poor, differing in its texture, and very distinct in its appearance.

It is generally level and flat—very compact, hard in dry and exceedingly miry in wet weather. Its color and consistence is that of a light clay. It produces but little, plaster does not act well on it, and at the best cultivation meets with but small returns. It is seen in the neighborhood of Port Republic; on the ridge section between the Chesapeake and the Patuxent near St. Leonards; near Lower Marlboro', and in various other parts of the county, and forms a large part of its soils. I do not give all of its localities, because those who are interested in its improvement will at once recognize it by this description, and the intercourse is so general amongst the inhabitants of this county, that it is unnecessary to point out its special localities.

This soil is mainly deficient in phosphate of lime, and should therefore be manured with manures containing most of this substance. Should marl be convenient, then it should be applied according to directions in my former Report. This will at once supply the needful quantity of phosphoric acid and lime, and do all that these soils require for productiveness. When marls are not convenient, then a small quantity of *air-slacked* oyster shell lime should be used, (from forty to sixty bushels per acre, with bone dust,) good Mexican or Columbian guano.

White Oak Soil.—This exists to some extent in this county, and for its treatment I refer to my former Reports; what was there said experience has demonstrated to be true, and I can only now repeat the directions I then gave to the owners of these soils. Wherever my directions have been carried out, either as regards their culture or manuring, there crops have increased at the cheapest rate, and permanent fertility has been the result. What I said as to the improvement of these soils has now been published more than six years, and I have yet to learn that any one has failed to reap large returns for all that he has expended in following the directions then given. If there has been any better mode discovered, those who have followed it should make it known for the public good. He who has a secret for the improvement of land and does not reveal it for the benefit of his brethren, does not do his duty, for the concealment of that which may benefit, is equivalent to the perpetration of a direct injury.

There are several other varieties of soil in this county which could be described so far as their outward appearance is concerned, but as I have not examined their inward and special qualities, I will not here say any thing of them. If allowed, I shall do this hereafter.

In this county there are on hill sides, even in the most productive lands, small spots, known as "knolls," which are barren and require constant manuring, even to be capable of producing tolerable crops. They are "eye sores" to their owners, and detract no less from the appearance of the fields, than from their average production. These knolls are always less loamy than the more level parts of the field, and are of a much deeper color. A specimen of them was sent to me by Mr. Alexander Somerville of Pt. Patience, and from his practical information and my own examination, I have deduced the following rules as to their improvement:

First, they should not be manured with finely rotted stable manure, nor with lime, but should be treated with coarse stable or barn-yard manure plowed in, or with the siftings from shell banks, or with compost manure from marshes or ditch banks. These applications will give a good texture to these places and supply them with all the necessary nutrient substances. A very full and complete report on them was given to the gentleman by whom they were sent, and I am only consoled in not having it to publish, by the knowledge that full information on this subject will be imparted to all those who seek it from him.

RESOURCES FOR IMPROVEMENT.—There is no county in the State that has so much means for the improvement of its soils, and perhaps none that has made generally so little use of them as Calvert county.

These natural resources are the very things which the soils most need to supply them with nutrient substances and improve their mechanical texture, viz: calcareous manures in the form of "Indian shell banks," which exist in various parts of the county, on the Patuxent border, and marls, of the variety of either clayey or sandy shell marls. Besides this, the river and the bay can furnish an *illimitable* amount of oyster shells that can easily be burnt into lime.

In my previous Reports, the mode of using these Indian shell banks has been very fully described, and those who have used them fully endorse their value. The coarse *mould* "sifting" which is separated from them in the process of screening, as an application for wheat or corn, equals a heavy dressing of Peruvian guano in the first, and lasts through many years.

The lime burnt from these shells is equal to the best fresh oyster shell lime, and peculiarly appropriate to all of the white oak lands, and those which contain a surplus proportion of magnesia.

The shell mould, now lying inactive and unused in the shell banks of Calvert county, is sufficient to produce, clear of all expenses attending its application, more money than is sufficient to pay all the expenses of the civil list of the county. But this is not its only resource for agricultural improvement. The quantity and extent of its marls, adapted in an especial manner to meet all the deficiencies in its soils, would seem fabulous to one unacquainted with their quantity. There is on the bay shore a marl bank of easy access showing a clear depth of about twelve feet and extending miles in length. A part of this marl is sandy marl, and particularly adapted to the stiff soils adjacent to it, another part is very stiff clay marl, and exactly suitable to the light soils in its vicinity. Not only are these marls found on the bay shore, but in many and various other parts of the county from the Anne Arundel border down to St. Leonard's Creek. They contain from thirty to eighty per cent. of carbonate of lime, (air-slacked lime,) and would, if applied, double the value of lands on which they might be used, and pay for the expense of their application in the first crop. I say this from a very extensive acquaintance with the effects of the marl, and this opinion is founded on more practical observation than has been attained by any one else in Maryland.

I now take leave of the description of the various soils examined since my last Report. I have given a full and complete description of all those which I was enabled to examine sufficiently to recommend appropriate manures and appropriate cultivation.

These recommendations I have founded on the most careful analyses of the soils and the lights afforded me by all the facts which I could obtain from practical observation. These I have carefully collated, and the result has been given to the agricultural community in the preceding pages.

The practical recommendations are based on a digest of facts obtained from practical men, from my own observation, the collection of those from all written sources in my reach, together with the teachings of chemical analysis conducted so as to give the most accurate results of which analytical chemistry is now capable.

My whole aim and endeavor has been in the foregoing Report to make myself clearly understood, and to attain this object I have sacrificed much in the style, preferring to use frequent repetitions, the better to convey a *clear* understanding of my meaning. If in any part there be obscurity or doubt, I will take great pleasure sion of his opinion.

Before concluding this Report, I feel it but right that I should call your attention to the law for the inspection of Peruvian and other guanos coming to our State. The supplement to the original bill passed by the last House of Delegates fixed a scale of numbers whereby the different qualities of Peruvian guano should be marked—for instance, it says all guanos containing from fifteen to eighteen per cent. of ammonia shall be marked with the same mark, the letter "A." All those containing from twelve per cent. to fifteen per cent. shall be marked with the letter "B," &c. Now the value of ammonia at the rate at which it sells in Peruvian guano is about twelve cents per pound, and the difference in the Peruvian guano *bearing the same mark* may amount in a ton to sixty-six pounds, worth seven dollars and ninety-two cents. So purchasers in buying this article may receive that which is worth either fifty-seven or fifty dollars as they may chance to obtain an article containing fifteen or eighteen per cent. of ammonia in the case of that marked "A," and the same is true in regard to that marked "B."

So in the case of the Mexican guano. No. "A" here includes all that containing from forty to fifty per cent. of phosphate of lime. A cargo containing forty per cent. of phosphate of lime bears the same mark and is sold at the same price as that containing nearly fifty per cent., and the purchaser cannot in either case tell which is the forty per cent. phosphatic guano, from that which is between forty-nine and fifty per cent. To obviate this as far as possible, the name of the ship should be marked on the bag and the dealer required to keep a certified analysis, which the purchaser could inspect at any time.

I have felt it my duty in several of my former Reports to speak of the law for the inspection of guano, and to recommend such modifications of it as would show as nearly as possible the per centage of its valuable constituents. In this I have not been actuated, as some have supposed, by personal ill-will to any of the incumbents who have filled the place of inspector of it, and especially true is this in reference to the incumbent who preceded the present inspector. He carried out the law as was done before his appointment to office, in the mode which custom had confirmed, which the tacit acquiescence of the Legislature had sanctioned, and with fully as much conformity to the law as has been done since, and I have never intended any thing which I have written to be construed into the impeachment of the *integrity* of any one who has ever been connected with that or any other office, but have only insisted on an *exact inspection of all fertilizers* sold in our public markets, without which the farmer and planter has no protection in purchasing them.

The present Report is submitted to your honorable body, under many disadvantages, but should it in any manner advance the interests of those for whom I am appointed to labor, then the object will have been accomplished for which I at first sought and have since remained in the office of State Chemist, and I will not in vain have devoted some of the best years of my life to the fulfilment of its many and arduous duties.

In conclusion, I tender my most sincere acknowledgments to the people of the counties which I have visited for their many acts of kindness and hospitality shown to me, and shall be happy for an opportunity to return them.

JAMES HIGGINS.

ERRATUM.

The reader will perceive that the pages in this Report from fourteen to nineteen are omitted. They did not contain any thing material to the principles of Agricultural Chemistry or Agricultural Practice, and as the errors in them were not discovered until they were worked off, I thought it best to leave them out, and settle with the printer myself, for all the trouble and expense attending these pages, as it would not be right that the people of the State should pay any thing for my errors.

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